PROCEEDINGS

of the

ENTOMOLOGICAL SOCIETY *of* BRITISH COLUMBIA

Volume 54 **Issued December 16th, 1957**

Proverbs—Control of soft scales (Homoptera: Coccidae) in British Columbia peach and apricot Orchards - - - 3
Atkins and McMullen—A note on sexing live specimens of *Scolytus unispinosus* Lec. (Scolytidae: Coleoptera) - - 8
Downes—Notes on some Hemiptera which have been introduced into British Columbia - - - - - - - - - - 11
Fulton—Soil insecticides for control of the tuber flea beetle, ***Epitrix tuberis*** Gent., in the lower Fraser Valley of - British Columbia - - - - - - - - - - - 14
Ross and Evans—Annotated list of forest insects of British Columbia Part VII — *Apatela* spp. (Noctuidae) - - - - - - 16
Ross and Evans—Annotated list of forest insects of British Columbia Part VI — *Plusia* spp. (Noctuidae) - - - - - - 18
Downing—Chemical control of the brown mite, *Bryobia arborea* M. & A., and of the clover mite, *B. praetiosa* Koch, in British Columbia 19
Condrashoff—A history of recent forest tent caterpillar infestations in the interior of British Columbia - - - - - - - - 21
Touzeau and Neilson—Plans to eradicate oriental fruit moth in the Okanagan Valley, B.C. - - - - - - - - - - 23
Forbes and Finlayson—Species of root maggots (Diptera: Anthomyiidae) of cruciferous crops in Brittish Columbia - 25
Spencer and Buckell—On the acridiophagous Sarcophagida of British Columbia with records of all others taken in the Province 29
Sugden—A brief history of outbreaks of the Douglas-fir tussock moth, *Hemerocampa pseudotsugata* McD., in British Columbia - 37
Hardy—Notes on the life histories of five species of Lepidoptera from southern Vancouver Island, British Columbia - - - 40
Fulton—Unusual damage to potatoes by the two-spotted spider mite, *Tetranychus telarius* (L.), in the lower Frsaer Valley - - 44
Kinghorn and Chapman—The effect of Douglas-fir log age on attack by the ambrosia beetle, *Trypodendron lineatum* (Oliv.) - - 46
Science Notes - - - - - - - - - 13, 17, 24, 39, 44, 45, 49, 51
Book Review - - - - - - - - - - - - - - - 50

PROCEEDINGS

of the

ENTOMOLOGICAL SOCIETY *of* BRITISH COLUMBIA

Volume 54 **Issued December 16th, 1957**

Proverbs—Control of soft scales (Homoptera: Coccidae) in British Columbia peach and apricot Orchards - - - 3
Atkins and McMullen—A note on sexing live specimens of *Scolytus unispinosus* Lec. (Scolytidae: Coleoptera) - - 8
Downes—Notes on some Hemiptera which have been introduced into British Columbia - - - - - - - - - - 11
Fulton—Soil insecticides for control of the tuber flea beetle, *Epitrix tuberis* Gent., in the lower Fraser Valley of British Columbia - - - - - - - - - - 14
Ross and Evans—Annotated list of forest insects of British Columbia Part VII — *Apatela* spp. (Noctuidae) - - - - - - 16
Ross and Evans—Annotated list of forest insects of British Columbia Part VI — *Plusia* spp. (Noctuidae) - - - - - - 18
Downing—Chemical control of the brown mite, *Bryobia arborea* M. & A., and of the clover mite, *B. praetiosa* Koch, in British Columbia 19
Condrashoff—A history of recent forest tent caterpillar infestations in the interior of British Columbia - - - - - - - 21
Touzeau and Neilson—Plans to eradicate oriental fruit moth in the Okanagan Valley, B.C. - - - - - - - - - - 23
Forbes and Finlayson—Species of root maggots (Diptera: Anthomyiidae) of cruciferous crops in Brittish Columbia - 25
Spencer and Buckell—On the acridiophagous Sarcophagida of British Columbia with records of all others taken in the Province 29
Sugden—A brief history of outbreaks of the Douglas-fir tussock moth, *Hemerocampa pseudotsugata* McD., in British Columbia - 37
Hardy—Notes on the life histories of five species of Lepidoptera from southern Vancouver Island, British Columbia - - - 40
Fulton—Unusual damage to potatoes by the two-spotted spider mite, *Tetranychus telarius* (L.), in the lower Frsaer Valley - - 44
Kinghorn and Chapman—The effect of Douglas-fir log age on attack by the ambrosia beetle, *Trypodendron lineatum* (Oliv.) - - 46
Science Notes - - - - - - - - 13, 17, 24, 39, 44, 45, 49, 51
Book Review - - - - - - - - - - - - - - - 50

DIRECTORS OF THE ENTOMOLOGICAL SOCIETY OF BRITISH COLUMBIA FOR 1957-58

Honorary President

W. MCGILLIVRAY, *Deputy Minister of Agriculture*

President

M. D. PROVERBS, Summerland, B.C.

President-Elect

P. ZUK, Vancouver, B.C.

Vice-President

D. A. ROSS, Vernon, B.C.

Secretary-Treasurer

L. C. CURTIS, Kamloops, B.C.

Honorary Auditor

G. B. RICH, Kamloops, B.C.

Editorial Committee

H. R. MACCARTHY, *Chairman* R. R. LEJEUNE

J. A. MARSHALL

Advisory Board

G. J. SPENCER, Vancouver, B.C. H. G. FULTON, Chilliwack, B.C.

M. G. THOMPSON, Victoria, B.C.

CONTROL OF SOFT SCALES (HOMOPTERA: COCCIDAE) IN BRITISH COLUMBIA PEACH AND APRICOT ORCHARDS[1]

M. D. PROVERBS[2]

Entomology Laboratory, Summerland, B.C.

Within the last eight years there has been a marked increase in numbers of soft scales on peach and apricot trees throughout the Okanagan Valley of British Columbia. *Pulvinaria* sp. is most frequently found on peach; one species of *Lecanium*, designated as *Lecanium* sp. A in this paper, evidently prefers apricot, whereas another species of *Lecanium*, designated as *Lecanium* sp. D, has been found only on peach. At least two other species of soft scales are present on tree fruits in the interior of British Columbia, but so far they have not been particularly troublesome.

The *Lecanium* scales overwinter as small nymphs, about three-fourths of a millimetre in length. They grow very rapidly during April and May, and commence egg-laying early in June. The eggs hatch during June and July, the date varying somewhat with the species, locality, and season. The young summer nymphs move to the leaves where they feed; they make very little growth during the remainder of the season. Just before the leaves fall in the autumn, the nymphs move to one- to three-year-old branches, where they pass the winter.

The life-history of *Pulvinaria* sp. is very similar to that of the *Lecanium* species. However, it begins egg-laying about two weeks earlier than the *Lecanium* scales, and the eggs commence to hatch about mid-June. Unlike the *Lecanium* scales, many of the summer nymphs of *Pulvinaria* sp. move from the leaves back to small branches during summer, and many of them are almost half-grown by autumn.

The scales devitalize the trees, and may kill one- and two-year-old twigs. They secrete copious quantities of honey dew, which makes the fruit sticky and sometimes unmarketable.

Field experiments were conducted from 1949 to 1955 on the chemical control of the scales on peach and apricot trees in the Okanagan Valley. A survey was also made to determine what species of insects parasitize or prey on these scales.

Materials and Methods

The following chemicals were used in the field experiments:

1. DDT, 50 per cent wettable powder; Pennsylvania Salt Manufacturing Company, Tacoma, Wash.

2. Demeton (Systox), 42.4 and 50 per cent liquids; Geary Chemical Company, New York, N.Y.

3. Diazinon, 25 per cent wettable powder of *O*, *O*-diethyl *O*-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate; Geigy Chemical Corporation, New York, N.Y.

4. Dieldrin, 50 per cent wettable powder; Shell Chemical Corporation, New York, N.Y.

5. Endrin, 18.5 per cent liquid; Shell Chemical Corporation, Julius Hyman Division, Denver, Colo.

6. Heptachlor, 25 per cent liquid (two pounds of heptachlor per U.S. gallon); Velsicol Corporation, Chicago, Ill.

7. Isolan, 25 per cent liquid of dimethyl 5-(1-isopropyl-3-methyl-pyrazolyl) carbamate; Geigy Chemical Corporation, New York, N.Y.

8. Lime-sulphur, liquid; specific gravity 1.28; Oliver Chemical Company, Penticton, B.C.

9. Lindane, two 25 per cent wettable powders, one from Pennsylvania Salt Manufacturing Company, Tacoma, Wash., and the other from California Spray-Chemical Corporation, Richmond, Calif.

10. Malathion, 50 per cent liquid; American Cyanamid Company, New York, N.Y.; 25 per cent wettable powder; Pennsylvania

1. Contribution No. 3670, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Entomologist.
3. All parasites were determined by Dr. O. Peck, Entomology Division, Ottawa.
4. Determined by Mr. J. F. McAlpine, Entomology Division, Ottawa.

Salt Manufacturing Company, Tacoma, Wash.

11. Nicotine sulphate, 40 per cent liquid; The N. M. Bartlett Spray Works, Beamsville, Ont.

12. Parathion, 15 per cent wettable powder; Naugatuck Chemicals, Elmira, Ont.

13. Polyethylene glycol, 600 mono ester of refined tall oil, liquid; The Emulsol Corporation, Chicago. Ill.; 600 mono laurate, liquid; Glyco Products Company, Incorporated, Brooklyn, N.Y.

14. Pyrenone T-503, liquid containing (w/v) 0.4 per cent pyrethrins, two per cent rotenone, and four per cent piperonyl cyclonene; U.S. Industrial Chemicals, Baltimore, Md.

15. Pyrolan, 40 per cent liquid of dimethyl 5-(3-methyl-1-phenyl-pyrazolyl) carbamate; Geigy Chemical Corporation, New York, N.Y.

16. Soap, powder; Lever Bros., Montreal, Que.

17. Sodium lauryl sulphate, 42 per cent powder; Canadian Industries Limited, Montreal, Que.

18. Stove oil; 34 S.S.U. Vis. 100°F., over 75 per cent U.R., Shell Oil Company, Penticton, B.C.

19. Strobane, 42 per cent liquid of terpene polychlorinate with a chlorine content of approximately 66 per cent; B. F. Goodrich Chemical Company, Cleveland, Ohio.

20. Toxaphene, 40 per cent wettable powder; Hercules Powder Company, Wilmington, Del.

21. Trithion 4E, liquid containing four pounds of *S*-(*p*-chlorophenylthio) methyl *O*, *O*-diethyl phosphorodithioate per U.S. gallon; Stauffer Chemical Company, Mountain View, Calif.

22. Washing soda, crystalline sodium carbonate ($10H_2O$); Church and Dwight Company, Montreal. Que.

Sprays were applied by high-pressure, hand-gun equipment, by air-blast, concentrate sprayers, and, in one instance, by bucket-pump sprayer. As a rule, there were at least eight trees per treatment, but treatments were replicated in only a few instances. Experiments were conducted when the insects were in various stages of development: over-wintered nymphs, mature and almost mature scales, and summer nymphs. Control was determined by one of the following methods: (1) As soon as the spray deposits were dry, scale-infested twigs were taken to the laboratory and the cut ends of the twigs immersed in water. Scale mortalities were recorded two to three weeks later. (2) Two to three weeks after spraying, scale-infested twigs were pruned from the trees, and scale mortalities immediately recorded. (3) The number of scales per leaf was recorded before and about two weeks after, spraying. Later, when it was found that dead scales remained attached to the leaves, the pre-spraying count was omitted and both living and dead scales were recorded in the post-spraying count. (4) As a rule, no counts were made of living and dead scales where the chemicals gave almost perfect control or very little or no control. In such instances, degree of effectiveness was estimated in the field by visual observation.

The species of parasites and predators present were determined by collecting, throughout the growing season, scale-infested twigs from peach and apricot orchards in the interior of British Columbia. The twigs, their cut ends immersed in water, were kept in battery jars in an insectary. Adult parasites that emerged from the scales were removed from the jars every day, and mounted on points for subsequent identification.

Results and Discussion

Chemical Control of *Lecanium* sp. A

Overwintered Nymphs—Mortalities of small, overwintered nymphs of *Lecanium* sp. A one month after apricot trees in the dormant stage were sprayed with lime-sulphur, or with lime-sulphur plus nicotine sulphate, were:—

Material	Gallons per acre	Average scale mortality, %
Lime-sulphur Nicotine sulphate, 40%	20 1	43
Lime-sulphur	20	33
Check	—	7

Mortality for each treatment was based on 500 scales; one twig was sampled from each of five trees.

When Diazinon or malathion was applied to peach trees showing ten

per cent full bloom, mortalities of overwintered nymphs of *Lecanium* sp. A two weeks later were:—

Material	Pounds per acre	Average scale mortality, %
Diazinon, 25%	12	97
Malathion, 25%	15	95
Check	—	23

Mortality for each treatment was based on 1000 scales; one twig was sampled from each of ten trees.

Despite the fairly high mortality in the Diazinon and malathion plots, the trees became moderately sticky with honey dew during the last week in May. Evidently, where the initial scale infestation is severe, the rating for satisfactory commercial control should be greater than 97 per cent scale mortality.

Mortalities of overwintered nymphs of *Lecanium* sp. A were estimated to be between 30 and 60 per cent ten days after apricot trees had been sprayed at the calyx stage with various chemicals. Mortality was highest with 42.4 per cent demeton at 0.25 pints per 100 gallons and lowest with a mixture of 40 per cent nicotine sulphate at one pint plus washing soda at 0.5 pounds. Intermediate in effectiveness were 25 per cent Lindane at one pound, 15 per cent parathion at one pound, and a mixture of 40 per cent nicotine sulphate at one pint plus polyethylene glycol ester of tall oil at one quart. At the time of spraying, the scales were about twice as large as they were during the winter, and probably they were more difficult to control than earlier in the season.

Mature and Almost Mature Scales —A summer spray of 25 per cent Lindane at 1.5 pounds per 100 gallons was ineffective against mature and almost mature scales of *Lecanium* sp. A on apricot. The addition of one quart of stove oil to the spray mixture gave no improvement.

In another apricot orchard, several chemicals failed to give satisfactory control of *Lecanium* sp. A when about 75 per cent of the scales had started to lay eggs. Twenty-five per cent malathion at one pound per 100 gallons killed many of the adult scales, but was innocuous to the eggs. Twenty-five per cent Lindane at one pound per 100 gallons, 50 per cent demeton at 0.5 pints, 15 per cent parathion at 1.5 pounds, a mixture of 40 per cent nicotine sulphate at one pint plus polyethylene glycol mono laurate at one quart, or a similar dosage of nicotine sulphate plus 2.5 pounds of soap had no ovicidal value, and evidently killed fewer adults than the malathion spray.

Summer Nymphs — A post-harvest application of 40 per cent nicotine sulphate at 1.5 pints, plus stove oil at one pint, per 100 gallons killed exposed, summer nymphs of *Lecanium* sp. A on apricot trees, but did not kill nymphs that were protected by the shells of the mother scales, and had no effect on the eggs. After all eggs had hatched, and the nymphs had moved from under the mother scales, an additional spray of nicotine sulphate plus stove oil (the dosage of nicotine sulphate reduced to one pint) gave very good control. No counts were made, but living scales were found only after prolonged search.

In another apricot orchard (Table I), a post-harvet spray of malathion gave excellent control of summer nymphs. However, a nicotine sulphate-stove oil mixture did not give as good control as in the previous experiment. This mixture has very poor residual properties, and was probably ineffective against most of the nymphs that moved from under the mother scales after spraying. With the possible exception of parathion, the other chemicals that were applied were not promising.

In another experiment in the same orchard (Table II), a post-harvest spray of malathion once again gave excellent control of summer numphs. As in the previous experiment, control with nicotine sulphate was not satisfactory, presumably because many of the nymphs were protected by the mother scales. The addition of stove

oil to nicotine sulphate evidently did not increase the effectiveness of the latter.

In a third apricot orchard, mortalities of summer nymphs were greater than 99.8 per cent 19 days after a post-harvest spray of 25 per cent Diazinon at two pounds, 25 per cent malathion at two pounds, or 25 per cent Trithion at one pint per 100 gallons. Mortality in the check plot was five per cent.

TABLE 1.—Average Numbers of Living Nymphs of *Lecanium* sp. A before, and Two Weeks after, a Post-harvest Spray of Various Chemicals to Single Apricot Branches by Bucket-pump Sprayer.

Material	Amount per 100 Gal.	Nymphs per Leaf[1]	
		Before Spraying	After Spraying
Malathion, 50%	1.3 pints	27	0.05
Parathion, 15%	1.0 lb.	12	0.9
Demeton, 42.4%	0.5 pints	21	8
Nicotine Sulphate, 40%	2.0 pints	17	11
Stove oil	2.0 pints		
Sodium lauryl sulphate, 42%	2.0 oz.		
Isolan, 25%	1.0 pints	14	9
Heptachlor, 25%	1.5 pints	27	15
Dieldrin, 50%	1.0 lb.	35	27
Endrin, 18.5%	0.5 pints	10	11
Strobane, 42%	2.0 pints	40	50
Pyrolan, 40%	0.5 pints	32	41
Check	—	33	44
Pyrenone T-503	1.0 pints	16	22

[1]Based on 20 leaves.

Chemical Control of *Lecanium* sp. D

Overwintered Nymphs—Mortalities of overwintered nymphs of *Lecanium* sp. D 15 days after peach trees were sprayed with Diazinon or malathion at the pink stage of blossom development were:—

Material	Pounds per 100 gallons	Average scale mortality, %
Diazinon, 25%	2	99.8
Malathion, 25%	2	99
Check	—	10

Mortality for each treatment was based on 500 scales; one twig was sampled on each of ten trees.

Another section of the same orchard was sprayed by a concentrate machine. Mortalities of slightly larger nymphs of *Lecanium* sp. D one month after a "calyx" spray of Diazinon plus DDT, or malathion plus DDT, were:—

Material	Pounds per acre	Average scale mortality, %
Diazinon, 25%	16	98
DDT, 50%	12	
Malathion, 25%	16	82
DDT, 50%	12	
Check	—	3

Mortality for each treatment was based on 1000 scales; one twig was sampled on each of 20 trees.

TABLE II.—Average Numbers of Living Nymphs of *Lecanium* sp. A before, and Two Weeks After, a Post-harvest Spray of Various Chemicals to Single Plots of Apricot Trees by Hand-gun Sprayer.

Material	Amount per 100 Gal.	Nymphs per Leaf[1]	
		Before Spraying	After Spraying
Malathion, 50%	1 pint	25	0.04
Nicotine sulphate, 40%	1 pint		
Stove oil	2 pints	28	10
Sodium lauryl sulphate, 42%	2 oz.		
Nicotine sulphate, 40%	1 pint		
Washing soda	8 oz.	45	17
Lindane, 25%	1 lb.	40	25
Check	—	37	38

[1]Based on 20 leaves from each of four trees.

Malathion plus DDT in the "calyx" spray did not give as good control of *Lecanium* sp. D as malathion alone in the earlier, "pink-bud" spray, even though the per-acre dosage of malathion was approximately 50 per cent greater (dosage at the pink-bud stage was approximately ten pounds per acre). Evidently the nymphs become more difficult to kill as they increase in size; at the calyx stage they were about 50 per cent larger than at the pink-bud stage.

Chemical Control of *Pulvinaria* sp.

Overwintered Nymphs — Lime-sulphur at 20 gallons per acre, used alone or with 40 per cent nicotine sulphate at one gallon, did not give satisfactory control of overwintered nymphs of *Pulvinaria* sp. on apricot trees in the dormant stage. Thirty-nine days after spraying the percentage mortalities were: Lime-sulphur, 89; lime-sulphur plus nicotine sulphate, 65; check, 5. The low mortality in the lime-sulphur-nicotine sulphate plot was doubtless partly due to poor spray coverage. A moderately strong wind was blowing when most of the trees in that plot were sprayed.

Mature and Almost Mature Scales — A mixture of 40 per cent nicotine sulphate at one pint, plus washing soda at 0.5 pounds, per 100 gallons, applied to peach trees at the calyx stage, had no observable effect on mature and almost mature scales of *Pulvinaria* sp. A similar quantity of nicotine sulphate, plus polyethylene glycol ester of tall oil at one quart, was equally ineffective. Fifty per cent malathion at 1.3 pints per 100 gallons, applied to apricot trees at about 90 per cent petal-fall, was also ineffective against these scales.

Summer Nymphs—Fifteen per cent parathion at 0.75 pounds per 100 gallons gave good control of *Pulvinaria* sp. nymphs on peach trees during June. Forty per cent nicotine sulphate at one pint plus soap at three pounds was not quite so effective. The sprays were applied when about 75 per cent of the eggs had hatched. Evidently parathion was sufficiently persistent to continue killing nymphs that emerged some days after spraying, whereas this was not so with nicotine sulphate. Very few scales were killed by 25 per cent Lindane at one pound per 100 gallons, or by 40 per cent toxaphene at 2.5 pounds.

Parasites and Predators

Parasites reared from *Pulvinaria* sp. and *Lecanium* spp. in the Okanagan Valley include *Coccophagus scutellaris* (Dalm.), *Aphycus kincaidi* (Timb.), and *Aphycus* sp. near *californicus* How. *Lecanium* spp. were also parasitized by *Coccophagus lycimnia* (Wlkr.) and *Microterys* sp.[3] Larvae of a predacious fly, *Leucopis* sp.[4], were found devouring large numbers of *Lecanium* eggs. Unfortunately, this predator was sometimes parasitized by *Pachyneuron eros* Gir. Various coccinellids (species not determined) attack soft scales in the Okanagan Valley, and anthocorids were seen feeding on *Lecanium* spp. in the laboratory. In the spring, birds of the finch family were observed feeding on overwintered nymphs of *Lecanium* spp.

Summary

In experiments from 1949 to 1955 in British Columbia peach and apricot orchards, a post-harvest spray of malathion, Diazinon, or Trithion gave excellent control of summer nymphs of *Lecanium* sp. A on apricot trees. Diazinon or malathion, at the pink-bud stage of peach, also gave good control of small, overwintered nymphs of *Lecanium* sp. D, but was not quite so effective against slightly larger nymphs of *Lecanium* sp. A at ten per cent full bloom. A summer spray of malathion, parathion, nicotine sulphate plus soap, nicotine sulphate plus polyethylene glycol mono laurate, lindane, lindane plus stove oil, or demeton did not give satisfactory control of mature and almost mature scales of *Lecanium* sp. A. Summer nymphs of *Pulvinaria* sp. were controlled in June by one application of parathion; both Lindane and toxaphene were ineffective. At least five species of Hymenoptera and one species of Diptera attack soft scales on peach and apricot trees in the Okanagan Valley.

Acknowledgments

Thanks are due to Mr. G. D. Halvorson of the Summerland Laboratory, and to Mr. H. A. Magel, now at the Canada Experimental Farm, Agassiz, B.C., for their assistance in the application of the sprays.

A NOTE ON SEXING LIVE SPECIMENS OF *SCOLYTUS UNISPINOSUS* LEC. (SCOLYTIDAE, COLEOPTERA)[1]

M. D. ATKINS and L. H. MCMULLEN[2]

A method for rapid, accurate determination of insect sex is often a valuable asset in field studies. Several sex differences, including one common to many species of *Scolytus*, and the results of testing their validity for field use, are presented here for *Scolytus unispinosus* Lec., the Douglas-fir engraver beetle.

In recent work it was necessary to determine the sex of a number of Douglas-fir engraver beetle adults in the field without injuring them. This led to an examination of adults under the microscope which revealed three differences in the external morphology of the sexes.

The first difference noticed in the attacking adults, was that the frons of the male bore a denser crown of setae than that of the female. This characteristic was used to sex 60 adults with a 10x hand-lens and then under 40x with a stereoscopic microscope. Subsequent dissections revealed that 14 errors were made with the hand lens, while only one was made using the microscope. The value of this characteristic is reduced after the beetles have been engaged in gallery construction, as the head setae become considerably worn.

A stable and reliable difference was found in the shape of the head as described for most members of this genus (Blackman, 1934). When viewed laterally, the front of the female's

1. Contribution No. 378, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Forest Biology Laboratory, Victoria, B.C.

Fig. 1.—Heads of male (left) and female (right) *Scolytus unispinosus* Lec., showing difference in shape and setation.

head is convex while that of the male is sloping and flattened to a point well behind the eyes. Both head shape and setation differences are shown in Fig. 1.

A sample of 40 beetles was sexed by the authors under 40x, using head shape as the differentiating character. Later dissections showed that no errors were made. As microscopic examination is inconvenient for field identification, two more samples were sexed with a 10x hand lens. Dissection showed that out of 65 beetles, only 3 were sexed incorrectly.

The third interesting sex difference results from behaviour. Once gallery construction has begun, and the male has assumed its duty of kicking the boring dust from the entrance hole, small particles of white frass adhere to the posterior sternites which form the posterior, ventral concavity (Fig. 2). As some males leave their galleries while new attacks are still being made, one cannot only tell the sex of the individuals, but also some of the past history of males by this observation.

Two interesting sidelights of the examination were the discovery of nematodes densely packed in the abdominal cavity of about 15 per cent of the adults, and the presence of a large hymenopterous larva in the abdominal cavity of 2 specimens.

Reference

Blackman, M. W. 1934. A revisional study of the genus *Scolytus* Geoffroy (*Eccoptogaster* Herbst) in North America. U.S.D.A. Technical Bulletin 431, 1-30.

Fig. 2.—Ventral view of male *Scolytus unispinosus* Lec., showing boring dust adhered to sternites of posterior ventral concavity.

NOTES ON SOME HEMIPTERA WHICH HAVE BEEN INTRODUCED INTO BRITISH COLUMBIA

W. DOWNES
Victoria, B.C.

In spite of the best efforts of the inspection service, foreign insects find their way into this province from time to time and some from eastern Canada and the United States. While frequently species which are most unwelcome obtain access, we have, within the last fifty years, received some which may prove of distinct economic value. My remarks are based upon experience in collecting Hemiptera in British Columbia since 1917.

Phytocoris tiliae L. This handsome Mirid has probably been present in British Columbia for a considerable time. It is fairly common in Britain and belongs to a family known to be largely predaceous in habit. Usually it is brightly mottled with light green and black. It is to be found on tree trunks, especially deciduous trees, and occasionally on wooden fences. In 1918 to 1923 I found it common on boulevard trees in Vancouver's west end at the food of Georgia and nearby streets, often accompanied by the slender thread-legged bug, *Empicoris pilosus* (Fieb.), another predaceous species. In 1954 I looked for it again in Vancouver and found it abundant on two decaying deciduous trees at the foot of Robson Street, on this occasion accompanied by numbers of another *Phytocoris* species new to B.C., (apparently the European *P. dimidiatus*, but not yet definitely identified). Although present on the mainland for such a long period *P. tiliae* has not yet been found on Vancouver Island.

Melanotrichus concolor Kbm. This is another European Mirid which feeds on broom, *Cytisus scoparius*. The insect is green, of about the same shade as the host. This species was first noticed on Vancouver Island in the late twenties. It is said not to be very abundant in Britain, but on Vancouver Island it swarms on the broom bushes to which it is definitely injurious.

Heterotoma meriopterum Scop. This curious Mirid is a European species which was recorded by Knight in 1917 from New York and is now found in British Columbia. It is very common on Southern Vancouver Island and the lower mainland. We took it first at Cedar Hill, Victoria, in 1933 where it was swept from broom bushes; but it is abundant on almost any kind of herbage and brush. It is dark brown or black and can be recognized at once by the first two joints of the antennae being swollen and thickly clothed with dark hairs; the third and fourth joints are bare and filiform. Little or nothing seems to be known of its life history but it does not appear to be harmful in any way.

Dicyphus pallidicornis Fieb. This European species was sent to me from Vancouver in 1944, but it has been present in Western North America for a considerable time, having been previously reported from Oregon. Its only known host is *Digitalis*, and if it confined its attentions to the common garden foxglove no great harm would be done. But it also attacks the medicinal Digitalis which is grown in some quantity in the Victoria district, and damages the plants extensively. It can be controlled by spraying with DDT. There are several generations during the summer; the last generation is usually brachypterous and hibernates among dead leaves and at the base of the plants. The species is abundant up and down the coast of British Columbia wherever foxgloves are grown.

Campyloneura virgula Fieb. This pretty species is allied to *Dicyphus* which it closely resembles. It is a native of Europe where it is known to be an efficient mite destroyer. My first record of it was in 1949 at Goldstream on Vancouver Island where it was swept from alder trees and nettles.

It has since been taken in small numbers at various points near Victoria and on the lower mainland. The insect is yellowish, the wings hyaline tinged with yellow, the thorax with a broad band of yellow, the base of the scutellum yellow, the apex white. The cuneus is bright yellow, the apical portion orange-red. I have swept it from alders, poplars and various kinds of brush. It may prove to be a useful addition to our fauna.

Orius minutus L. This small Anthocorid was discovered by Norman Tonks on Lulu Island on the lower mainland in 1951 on raspberries and logans. It is a European species common in Britain. Our only known native species is *Orius insidiosus* from which *minutus* is readily distinguished by its overall brown colour and broader outline. *O. minutus* is predaceous on mites and small insects and may prove to be a useful species. So far the lower mainland is the only locality record.

Gargara genistae Fab. This is one of the only two species of treehoppers found in Britain. It has previously been known to occur in New Jersey where it was taken in 1917. In 1934 I took it at Cedar Hill, Victoria, on broom. Since that time *G. genistae* has spread to Goldstream eleven miles west. It is not known to be injurious.

Arytaina spartiophila (Forst.). In 1949 this Psyllid occurred in enormous numbers on broom, *Cytisus scoparius*. That was the first year it had been recorded in British Columbia. It has been introduced from Europe and was first recorded at Fort Lewis, Washington, in 1935. When in large numbers it does heavy injury to broom. This is not entirely to be deplored since, over the years, broom has formed dense thickets, often eight feet high on the Goldstream hills. Such thickets are a fire hazard, and effectually smother second growth. A check to the advance of broom may prove to be an advantage. Many areas formerly in grass are now covered with broom.

Graphocephala coccinea (Forst.). This leafhopper, which is common in Eastern Canada in shady woods, was numerous on rhododendrons at a nursery outside Victoria in 1941. It is strikingly marked with broad stripes of red and green. It does not seem to have spread in the Victoria area, but may still be present on rhododendron.

Stictocephala bubalus (Fab.). The buffalo treehopper was not known as a native species in this province prior to 1920, when I received a specimen collected on the Agassiz Experimental Farm where it had probably been introduced on nursery stock. A few years later *S. bubalus* appeared in the southern Okanagan, but this may have been a separate introduction. The species is now well established. It does harm to several kinds of fruit trees by ovipositing in the twigs.

Stictocephala diceros (Say). This is recorded only from Agassiz, B.C., from where I received a number of specimens in 1925 and 1926, but none since. It does not appear to have spread, and has never been recorded from interior districts. It was probably introduced from eastern Canada in nursery stock.

Macropsis fuscula Zett. This European species appeared on logans and raspberries on Lulu Island in the lower Fraser Valley in 1952 and within a year increased to enormous numbers. By 1954 it had spread 30 miles up the Fraser Valley where it was found on varieties of wild *rubus*. The introduction of this species is most unfortunate on account of the hazard to the loganberry industry. It has already spread to Vancouver Island, which was to be expected, since the site of the original infestation is close to the airport. Without such artificial means of distribution it might have been confined to the lower mainland for a long period as has been the case with other species. This occurrence has been adequately reported elsewhere by H. Andison (Can. Ins. Pest Rev. 32(1): 4. 1954).)

Macropsis virescens var. graminea (Fab.). This was first taken by me at Haney on poplars in 1954. It is a European species now widely distributed in North America but is not expected to prove of any particular economic importance.

Idiocerus decimusquartus Schr. This name now takes precedence in the case of this leafhopper which was long known as *Idiocerus scurra*. It is another denizen of poplar trees and is known to have been present on the lower mainland since 1922, when I received a specimen collected at New Westminster. This is a European species, present in North America for a long time, which may have come to British Columbia in the egg stage in the first poplars brought here. Like several other species it has apparently not yet succeeded in crossing to Vancouver Island.

Allygus mixtus (Fab.). This large handsomely marked European leafhopper was first noticed on Vancouver Island in 1948, but probably it had arrived some years earlier since it was already well distributed over the southern districts. It is an active flier, so its spread could be quite rapid. It now occurs on the mainland, breeding on oak and other deciduous trees and on snowberry (*Symphoricarpus*). So far it has not proved injurious.

There are several other species which have been edging their way across the continent for years, but cannot be mentioned here. Others will, no doubt, continue to arrive; it is some comfort to know that, in the case of Hemiptera, many are harmless, and some are definitely beneficial.

An unusual flight of termites

Emergence of alate first reproductives of the most commonly occurring termite in the lower Fraser Valley, *Zootermopsis angusticollis* Hagen, may occur during almost any month of the year (Jacob, J. K. The Termites of British Columbia, their structure, bionomics and intestinal fauna. Unpublished Masters' Thesis, University of British Columbia, 1938). I have personally observed them from January to May and from August to November. For some years now I have watched the autumn flight along the north slope of the Point Grey Peninsula any time between the end of August, through September. These termites abound in old logs that lie half buried in sand or gravel in various stages of decay on both sides of Burrard inlet. They are in a surprisingly high percentage of older homes in the Kerrisdale-Kitsilano area and may occur almost anywhere in Vancouver where earth is in contact with the stucco or wooden siding of a house and rot sets in. Garages whose flooring rests on timbers directly in contact with the earth and buildings with damp, dead-air spaces below them, are particularly susceptible.

The autumn flight of termites along the Point Grey peninsula can be directly followed by the movements of large flocks of Bonaparte's gulls (*Larus philadelphia* Ord.) which pluck the termites out of the air. Professor Cowan told me that he has shot the birds during these manoeuvres and has found them packed with termites. One-time residents of Gambier Island have assured me that they have frequently watched this behaviour amongst large gulls also, so it is probably general along our coasts wherever termites swarm. Normally, off Point Grey, this flight occurs from 300 to 500 feet above ground and extends inland from the sea beaches for possibly one quarter of a mile. But in the early evening of August 1, 1956, an unusually large number of these delicate, black-headed gulls hunted termites from the sea shore inland and overhead until they passed southwards out of sight. The line of diving, twisting gulls stretched east and west as far as one could see, at about the height of tall, old fir trees nearby, which would be between 150 and 200 feet. Five days later some residents of South Burnaby described to me this flight of gulls stating that it had come from the north and had passed southwards over the Fraser River and out over Lulu Island.

In past years, it would seem that the supply of winged termites gave out within a few hundred yards of the sea shore but the flight of termites on August 1, 1956, must have exceeded all previous ones to have supplied the birds with food for several miles.—*G. J. Spencer, Dept. of Zoology, University of British Columbia.*

SOIL INSECTICIDES FOR CONTROL OF THE TUBER FLEA BEETLE, *EPITRIX TUBERIS* GENT., IN THE LOWER FRASER VALLEY OF BRITISH COLUMBIA[1]

H. G. Fulton[2]

Entomology Laboratory, Chilliwack, B.C.

The tuber flea beetle, *Epitrix tuberis* Gent., was first reported from the southwestern coastal area of British Columbia in 1940. The losses resulting from the larval feeding in tubers were severe, so that it was necessary to develop control measures. This is a summary report on experiments to destroy larvae conducted mainly from 1947 to 1955 on clay loam, sandy to gravelly loam, and silt soils in the Agassiz and Chilliwack areas. The work was carried on under the direction of Mr. R. Glendenning, Officer-in-Charge, Entomology Laboratory, Agassiz, until his retirement in 1953, and was continued by the writer after that time.

Early experiments showed that a thorough application to potato foliage of DDT and calcium arsenate, or DDT alone, reduced damage to the tubers by destroying the beetles. However, this method of control sometimes failed when materials were not applied early, often, or thoroughly enough or when weather conditions were unfavorable. The economic advantage of foliar application is that insecticides may readily be combined with sprays which are routinely applied to control late blight.

An experiment in 1944 on the value of five materials applied to the foliage showed that tuber damage was by no means proportional to the numbers of adults. With the advent of stable organic insecticides effective against soil insects, experiments were conducted on ways of killing the larvae.

Preliminary tests in 1945 and 1946 with both field- and pot-grown potatoes showed that neither calcium arsenate nor cryolite was effective as a larvacide in the soil. The best control was obtained with dust containing DDT and calcium arsenate applied to the foliage.

Experiments in 1947 showed that BHC from different sources applied to the surface and worked into the soil by various methods gave excellent control, but caused phytotoxicity at certain rates. Stored tubers from all the BHC plots developed the characteristic taint and were very distasteful by spring.

In 1948 similar experiments with BHC confirmed the previous year's results. DDT in the soil did not give any control. The standard control remained a dust of DDT and calcium arsenate on the foliage.

Tests in 1949 showed that soil pH had little or no effect on the control achieved with either crude or refined BHC, nor did acidity or alkalinity prevent tainting. Good control was achieved with chlordane worked into the soil. Four applications of the standard control proved insufficient, possibly because the first application was not made soon enough.

In 1950, single applications of chlordane, aldrin, and lindane broadcast and incorporated into the soil at various rates were compared with DDT and methoxychlor applied to the foliage. The soil treatments gave excellent control, but four foliage treatments with DDT or methoxychlor were not effective. Tubers from the plots treated with lindane were condemned because they were off-flavored.

In 1951, one of the two experiments intended to check the data on single soil applications of aldrin and chlordane was a failure because of poor

1. Contribution No. 3587, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Officer in Charge.

tillage. The area occupied by the experimental plots had been the site of permanent hedgerows of evergreens for many years. These had only recently been removed and it was impossible to put the soil in a condition of good tilth. The other experiment demonstrated 97 per cent control with aldrin at 2½ pounds per acre.

No experiments were set up in 1952 because the question of residue hazards had not been settled.

In 1953, replicated experiments were conducted with aldrin, dieldrin, and heptachlor dusts and granular heptachlor, each at 3.6 pounds of toxicant per acre and incorporated into the soil in a 12- to 14-inch band along the row. The best control was 77 per cent with aldrin, which indicated that the insecticides should be distributed in a wide band, as better control had been obtained with aldrin broadcast at lower rates. Granular heptachlor gave only 47 per cent control; the

TABLE I.—Percentages of control of the tuber flea beetle after single soil applications of various insecticides by three methods, Sardis, B.C., 1954.

Material	Toxicant per Acre, pounds	Method of application	Infestation index	Control %
Aldrin, 2.5% dust	4	Broadcast, deep working	6.87	95.0
	4	Broadcast, shallow working	5.62	95.8
	2	6-inch band, shallow working	33.75	75.4
Aldrin, 5.0% granular	4	Broadcast, deep working	9.25	93.1
Heptachlor, 2.5% dust	4	Broadcast, deep working	4.50	96.6
	4	Broadcast, shallow working	12.50	90.6
	2	6-inch band, shallow working	20.75	84.4
Check		No treatment	133.25	0
Difference necessary for significance at 5% level				16.5

[1]Average for 100 tubers taken at random from each of 4 replicate plots, washed, and weighted as follows according to 4 categories of damage: clean, up to 3 light injuries, 0; light, 4 to 15 feeding marks, 1; medium, 16 to 30 feeding marks, 2; heavy, over 30 feeding marks, 4. Clean and light categories marketable. Maximum infestation index: 400.

carrier used was later found to have contributed to a rapid loss of toxicity. Chlordane was not tested in 1953 because of limitations of space and labor.

In 1954, tests were conducted on shallow and deep incorporation of aldrin and heptachlor dusts and granular aldrin after broadcasting, and on a narrow, 6-inch band treatment with the two dusts. Table I shows that the broadcast treatments gave excellent control. There was no significant difference between materials worked into the soil deeply with a rotary cultivator and those worked in shallowly with a hand rake. The band treatment was more economical but significantly less effective.

In 1955, dusts of aldrin, dieldrin, heptachlor, and chlordane were each tested at three rates to establish minimum dosages. Before planting, the dusts were broadcast on the surface and worked into the soil by light hand raking. The rates in pounds per acre were: aldrin and heptachlor, 4, 3, and 2; dieldrin, 2, 1½, and 1; chlordane, 10, 7½, and 5. An unusually light infestation helped to

reduce to insignificance the differences between the treatments, which were all at or close to 100 per cent effectiveness. No experiments were conducted in 1956.

Summary

Experiments from 1940 to 1955 on clay loam, sandy to gravelly loam, and silt soils showed that satisfactory protection of potatoes from larvae of the tuber flea beetle can be obtained by broadcasting and incorporating a single application of one of several chlorinated hydrocarbons into the soil before planting. Effective materials were: aldrin, dieldrin, heptachlor, and chlordane. Incorporating the insecticide into the soil over the entire area was superior to either narrow or wide band application. No apparent differences in control were noted with deep or shallow incorporation. BHC and lindane caused off flavors in the tubers during storage. Given soil in good tilth, soil treatment is simpler and more reliable than foliar applications, although the latter are still popular because the insecticides can be applied in the spray necessary to control late blight.

ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA PART VII — *APATELA* SPP. (NOCTUIDAE)[1]

D. A. ROSS[2] *and* D. EVANS[3]

More than 20 species of *Apatela* (*Acronycta*) are known to occur in British Columbia. The larvae feed on deciduous-leaved trees, shrubs, and herbs, and, although occasionally numerous, are of little or no economic importance. No severe tree defoliation by species of *Apatela* has been reported in British Columbia. The larvae have the typical body structure of garden cutworms; unlike the common cutworms, a number of species are clothed with medium to very long, sparse to dense hairs. Body colours are: green and brown, yellowish, brown, or black. The *Apatela* larval head is slightly bilobed; it bears primary setae only.

Most, if not all, local species overwinter in the pupal stage within cocoons in the bark or on the ground.

A. dactylina Grote. *Salix* spp.; Southern Interior, notably along the Big Bend Highway, between Revelstoke and Mile 80; found also on *Alnus tenuifolia* at Aleza Lake and Yard Creek. **Larva:** 2½ inches long; head glossy black; body blackish, with dorsal transverse bands of short brush-like orange hairs; hairs on sides yellowish; dorsal, closely-paired pencils of long black hairs on A_1, A_2 and A_8.

A. lepusculina Gn. *Populus tremuloides, Salix* spp.; Central and Southern Interior and Vancouver Island. **Larva:** 1¼ inches; head black with some whitish markings on frons and sides; body yellowish or greenish excepting blackish venter and dorsal stripe; clothed with soft, long yellow hairs; black pencil tuft on abdominal segments 1, 3, 4, 5, and 8.

A. leporina L. *Populus tremuloides, P. trichocarpa, Salix* spp.; Cuisson Creek Quesnel, Castle Rock, and Cluculz Lake. **Larva:** 1¼ inches; head and body greenish-white; clothed with very long, curved white or yellowish hairs (curved forward on one side, backward on the other) and a few black ones at the end of the abdomen; there may be 3 to 5 black dorsal spots on the dorsum of the abdomen, vestiges of black pencil tufts that occur in early instars.

A. innotata Gn. *Betula papyrifera;* Central and Southern Interior. **Larva:** 1½ inches; top of head reddish-brown, front flesh-coloured, remainder blotched with black; body brown, tinged with blue and purple; small "warts"

1. Contribution No. 376, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Forest Biology Laboratory, Vernon, B.C.
3. Forest Biology Laboratory, Victoria, B.C.

on dorsum black, pale centred; "warts" on sides white; yellow spot between each set of setae i and ii; clothed with rather sparse medium long grey hairs.

A. radcliffei Harv. *Prunus emarginata, Amelanchier* sp., *Sorbus occidentalis;* Narcosli Creek, China Creek, Oyama and Revelstoke and Vancouver Island. **Larva:** 1½ inches; upper half of head reddish-brown, remainder black; pronotal shield black; dorsum and venter of body purplish-brown or blackish; sides, dorsal, and subdorsal lines yellow; sparse medium to long hairs on body.

A. grisea Wlk. *Alnus* spp., *Salix* Spp., *Betula papyrifera, Prunus pennsylvanica* (1 record), *Corylus* sp. (1); Central Interior and Southern B.C., and Vancouver Island. **Larva:** over 1¼ inches; head brown, excepting green frons; body green; brown dorsal stripe widened posteriorly, enclosing green portion on A_5 to A_7, stripe edged in part with yellow; small brown patch about each spiracle and above each proleg and true leg.

A. funeralis G. & R. *Acer glabrum, Betula papyrifera, Salix* spp., *Alnus* sp.; Shuswap Lake, Hupel, Trinity Valley, Aleza Lake, Salvus. **Larva:** head and body black; an oval yellow to orange-coloured patch on dorsum of each body segment, those on the abdomen with a black transverse line through each; long black spatulate setae (seta ii) on the dorsum of abdominal segments 1 to 6 and 8 to 9; additional spatulate setae occur on the first thoracic segment.

A. fragilis Gn. *Betula papyrifera, B. occidentalis, Sorbus occidentalis, Amelanchier* sp., *Prunus* spp., *Salix* spp.; Central Interior, Southern B.C. and V. I. **Larva:** 1¼ inches; head green and brown; body green with broad brown dorsal patch on each segment; pale "warts" with sparse long hairs; no markings on sides of body.

A. impleta Wlk. *Alnus* sp., *Salix,* sp., *Populus* sp.; Alberni, Langford, V.I.; Rivers Inlet, Cinnemousun Narrows, Downie Creek.

A. impressa Wlk. *Salix* spp., *Alnus* sp.; Central B.C., and Yukon Territory. **Larva:** "reddish or tan head; body black, large yellowish and orange tubercles; yellowish and buff coloured setae". According to Forbes (1954) the larva has a red substigmatal line.

Reference

Forbes, W. T. M. 1954. Lepidoptera of New York and Neighboring States — Noctuidae, Part III. Memoir 329, Cornell Univ. Agric. Exp. Sta.

On the feeding preferences of *Perimegatoma vespulae* Milliron (Coleoptera: Dermestidae)

Perimegatoma vespulae Milliron was accidentally brought to the University during the middle thirties in insects that had been collected in the dry belt during the summer. Infestation apparently had occurred when the pinned insects were left out to dry before being put into store boxes.

Since *P. vespulae* is parthenogenetic one beetle loose in a museum room can reproduce without having to fly out of doors to feed, so notwithstanding utmost precautions, every now and then a larva turns up in a cabinet drawer. I have isolated a pupa of this beetle, placed it on powdered fox chow in a tight container, watched the beetle mature, emerge, lay eggs, and watched the eggs hatch to minute larvae, whose capacity to pass between the top of a store box and its lid is astonishing.

For the past ten years or so larvae of this beetle have also been brought down from the dry belt in botanical specimens. Infestation of this material seems to begin in the field during the drying process. When the plants are mounted and distributed to the steel herbarium cabinets, the larvae in the folders may feed undisturbed for long periods, and move to other folders.

When found thus, the larvae are catholic in their tastes, feeding upon petals, buds and leaves of many plants except conifers. However, for initial attacks the beetles appear to show preferences in this order:— Ranunculaceae; Scrophulariaceae, especially *Castilleja;* Compositae, especially *Solidago;* Saxifragaceae, especially *Ribes,* and Aceraceae, especially maple flowers.

I am indebted to Professor T. M. C. Taylor and to Dr. K. Beamish for noting the host preferences in the herbarium.

—*G. J. Spencer, Dept. of Zoology, University of British Columbia.*

ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA
PART VI — *PLUSIA* SPP. (NOCTUIDAE)[1]

D. A. ROSS[2] *and* D. EVANS[3]

Although some species of this genus of defoliators are common, none has been recorded in "outbreak proportions". Unlike most other genera of the Noctuidae, *Plusia* (*Syngrapha* and *Autographa*) larvae have, in addition to the anal prolegs, only two pairs of ventral prolegs. The larvae are green, with stripes and longitudinal strips of minute black spinules. Most species have black pinacula, at least on upper portions of the body. *Plusia* spp. overwinter as small larvae.

P. rectangula Kby. *Pseudotsuga taxifolia, Tsuga heterophylla, Abies lasiocarpa, Picea engelmanni, P. glauca, Pinus monticola* (1 record); Southern B.C. and Central Interior. **Larva:** 1 inch; fairly broad white addorsal and subdorsal stripes, the addorsal slightly broader than the subdorsal on central abdominal segments; spiracular stripe, white, edged dorsally with cream.

P. alias Ottol. *Picea engelmanni, P. glauca;* Southern B.C. and Central Interior. **Larva:** length, 1¼ inches; addorsal, subdorsal and spiracular stripes, white, the subdorsal wider than the addorsal.

P. sp. nr. **alias.** *Picea glauca, P. engelmanni;* Southern and Central Interior. In correspondence, Hardwick stated the following about this form: " . . . while superficially resembling *alias*, they do not appear to be conspecific."

P. celsa Hy. Edw. *Tsuga heterophylla, Abies lasiocarpa, Abies grandis, Picea glauca* (1 record); Southern B.C. and Central Interior. **Larva:** addorsal, subdorsal, and spiracular stripes, white, the addorsal broader than the subdorsal although it may appear subequal; fairly prominent black pinacula.

P. angulidens Sm. *Abies lasiocarpa,* Penticton.

P. selecta Wlk. *Picea glauca, P. engelmanni, P. sitchensis, Pseudotsuga taxifolia, Abies lasiocarpa, Pinus contorta, Tsuga heterophylla* (2 records); Central Interior and Southern B.C.; common. **Larva:** length 1¼ inches; head pale green, faintly dotted with brown; body uniform bright green with narrow white addorsal and subdorsal stripes, of equal width on the abdomen; addorsals very narrow on thorax; spiracular — subspiracular stripe, cream; small black pinacula. (One seta immediately above each meso- and metathoracic leg on *selecta,* two on *celsa* and *alias* [two also on *rectangula*]), McGuffin, 1954.

P. epigaea Grt. Two fully grown larvae have been collected and reared, one from *Populus tremuloides,* Cranbrook, the other from *Pinus contorta,* Salmon Arm. Jones (1951) notes the host as *Vaccinium* spp. **Larva:** 1 inch; head, pale green, black lateral line on head under ocelli; body pale green; addorsal, subdorsal (narrower than addorsal) lines and spiracular stripe, white; small pinacula, white not visible to naked eye; a single seta above each meta- and meso-thoracic leg.

P. ampla Wlk. *Alnus* sp.; Union Bay on V.I., Cultus Lake, and Shuswap Lake.

1. Contribution No. 375, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Forest Biology Laboratory, Vernon, B.C.
3. Forest Biology Laboratory, Victoria, B.C.

Acknowledgment

The writers are indebted to D. Hardwick, Division of Entomology, Ottawa, for the identification of our *Plusia* **adults.**

References

Jones, J. R. J. L. 1951. An annotated check list of the macrolepidoptera of British Columbia. Ent. Soc. B.C. Occas. Paper No. 1.

McGuffin, W. C. 1954. Descriptions of larvae of forest insects: *Syngrapha, Autographa.* Canad. Ent. 86: 36-39.

CHEMICAL CONTROL OF THE BROWN MITE, *BRYOBIA ARBOREA* M. & A., AND OF THE CLOVER MITE, *B. PRAETIOSA* KOCH, IN BRITISH COLUMBIA[1]

R. S. DOWNING[2]

Entomology Laboratory, Summerland, B.C.

The mite previously known as the clover mite, *Bryobia praetiosa* Koch, has recently been separated into two species. *Bryobia arborea* M. & A. and *B. praetiosa* Koch, and the common names, brown mite and clover mite, respectively, have been suggested (Morgan and Anderson, in press). Although the two mites are closely related, differences in their life-histories, as shown by Anderson and Morgan (in preparation), are important in determining chemical control procedures.

The brown mite is an orchard pest. Its life-history and feeding habits are similar to those of the European red mite, *Metatetranychus ulmi* (Koch), but, except for occasional outbreaks, it is not so important a pest. The clover mite, on the other hand, is not strictly an orchard pest. It feeds on a wide range of herbaceous plants, from which it often moves into dwellings; consequently it is better known as a household pest.

This report compares the chemical control of these two closely related mites.

Chemical Control of the Brown Mite

At the pink bud stage of apple tree development the brown mite is in the larval or early nymphal stage and is particularly vulnerable to chemical control. It has been reported that the systemic preparations demeton (Systox, Geary Chemical Company, New York, N.Y.) and schradan (Pestox 3, Pest Control Limited, Cambridge, England) (Downing, 1953), and the sulpho esters fenson (Murvesco, Murphy Chemical Company, Wheathampstead, England) and ovex (Ovotran, Dow Chemical Company, Midland, Michigan) (Downing, in press), in pink bud applications have given excellent control of the brown mite for the whole season. Fenson and ovex, having lower mammalian toxicity than Systox and schradan, are the recommended materials in British Columbia.

The brown mite can also be controlled in the summer months (Downing, in press) but, owing to the presence of eggs as well as active mites, acaricides are less effective as summer applications than as pink bud applications.

Chemical Control of the Clover Mite

The life-history of the clover mite is more complex than that of the brown mite. Although the former species overwinters mainly in the egg and adult stages, larvae and nymphs are sometimes present, too. Consequently chemical control cannot be directed against active stages alone, as with the brown mite. To be highly effective against the clover mite, an acaricide must be effective against eggs as well as active stages, or have a persistent residual effect.

Most of the chemical control experiments carried out against these mites in the interior of British Columbia were conducted around homes and in gardens. The acaricides were applied with a bucket pump sprayer to outside walls of homes, or to infested grasses and ornamental plants nearby. The abundance of mites was not estimated by sampling and counting; instead, it was approximated by general observation of treated areas before and after spraying.

Sulphur dust has been recommended in some areas for the control of the clover mite around homes (Zappe, 1939); but several householders in

1. Contribution No. 3668, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Associate Entomologist.

Summerland and Penticton claimed it was ineffective. An experiment was carried out by dusting wettable sulphur on the soil around the foundation of a home in May, 1955. Although the mites moved freely through the sulphur they survived with little or no sign of injury.

On another occasion malathion, a chemical recommended for control of the brown mite on fruit trees, was used by a householder to control the clover mite; he claimed poor results. A second experiment was undertaken, therefore, to determine the control of the clover mite by each of three acaricidal mixtures. The materials were applied as sprays to separate areas on the walls of the house, to the soil at the bases of the walls, and to plants in the garden. Malathion (25 per cent; Pennsylvania Salt Manufacturing Company, Tacoma, Washington) at two pounds per 100 gallons and wettable sulphur (92 per cent; Canadian Industries Limited, Montreal, Quebec) at two pounds were each ineffective. Kelthane (18.5 per cent 1, 1-bis (*p*-chlorophenyl) 2, 2, 2-trichloroethanol; Rohm and Haas Company, Philadelphia, Pennsylvania) at two pounds on the other hand, gave satisfactory control.

The following year, May, 1956, Kelthane (18.5 per cent) was compared in the laboratory and in the field with Sulphenone (Sulphenone 50-W, containing 40% *p*-chlorophenyl phenyl sulphone and 10% related diaryl sulphones; Stauffer Chemical Company, Mountain View, California). The latter is currently recommended in British Columbia for summer control of the brown mite on fruit trees. In the laboratory a sheet of filter paper was dipped in an aqueous acaricidal suspension and allowed to dry. Then the sheet was placed in the bottom of a quartsize frozen-food container into which about 30 mites were introduced. The mites were confined in the container for two days, after which living and dead mites were recorded. There were five replicates per treatment. Kelthane, two pounds per 100 gallons, allowed eight per cent survival; Sulphenone, four pounds allowed 31 per cent; in the untreated control, survival was 87 per cent.

The two acaricides were applied to separate areas on the outside walls of a house heavily infested with the clover mite, and to the soil at the bases of the walls and to the lawn for a distance of eight feet from the house. Kelthane, two pounds per 100 gallons, gave excellent initial and residual control of the mites; Sulphenone, although fairly effective, was obviously inferior.

Summary

The brown mite, a species that attacks fruit trees, was satisfactorily controlled with a pre-bloom spray of fenson or ovex, or either of the systemic insecticides schradan and Systox. The clover mite, which occurs as a pest on grasses and a wide range of herbaceous plants and is a pest in and around homes, was controlled with one application of Kelthane. Sulphenone controlled the clover mite fairly well, but was not so effective as Kelthane, whereas malathion and wettable sulphur were unsatisfactory.

References

Anderson, N. H., and C. V. G. Morgan. Life-histories and habits of the clover mite, *Bryobia praetiosa* Koch, and the brown mite, *B. arborea* M. & A., in British Columbia (Acarina: Tetranychidae). In preparation.

Downing, R. S. Preliminary orchard trials with systemic insecticides. Proc. Ent. Soc. British Columbia 49:24-26. 1953.

Downing, R. S. Recent trials with new acaricides in British Columbia. Can. J. Plant Sci. In press.

Morgan, C V. G., and N. H. Anderson. *Bryobia arborea* n. sp. and morphological characters distinguishing it from *B. praetiosa* Koch (Acarina: Tetranychidae). Canadian Ent. in press.

Zappe, M. P. Clover mite in dwellings. *In* Connecticut State Entomologist, thirty-ninth report, 1939, pp. 317-318. Connecticut Agr. Expt. Sta. Bull. 434. 1940.

A HISTORY OF RECENT FOREST TENT CATERPILLAR INFESTATIONS IN THE INTERIOR OF BRITISH COLUMBIA

S. F. CONDRASHOFF[2]

The forest tent caterpillar, *Malacosoma disstria* Hbn., (*M. erosa* (Stretch)), was recorded in the interior of British Columbia as early as 1906. In the past the species was known primarily as a pest of shade trees and shrubs in parks, resort areas, and about homes. Recently the insect has been considered important as a forest species and has received added attention from the Forest Insect Survey. The forest tent caterpillar is of interest in studies on population dynamics, natural control, and as a possible indicator species for predicting outbreaks of other forest insect species. Though severe infestations have resulted in complete defoliation tree mortality has not been recorded in British Columbia.

Earliest records of infestation found by the author dated to 1923 and 1924 as occurring in "Interior B.C.", and in the Revelstoke area. Infestations were recorded for the period 1934-1939 at Vernon, Salmon Arm, Kamloops, and "Interior B.C." For the period 1939-1946 records were more numerous, but unfortunately neither continuous nor complete.

Beginning in 1946 the Forest Insect Survey included *Malacosoma disstria* among the species to receive special attention, resulting in the accumulation of more reliable and continuous records on infestations.

In 1948 an infestation was found at Quesnel which continued during subsequent years. In 1950 infestations

1. Contribution No. 404, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Forest Biology Laboratory, Vernon, B.C.

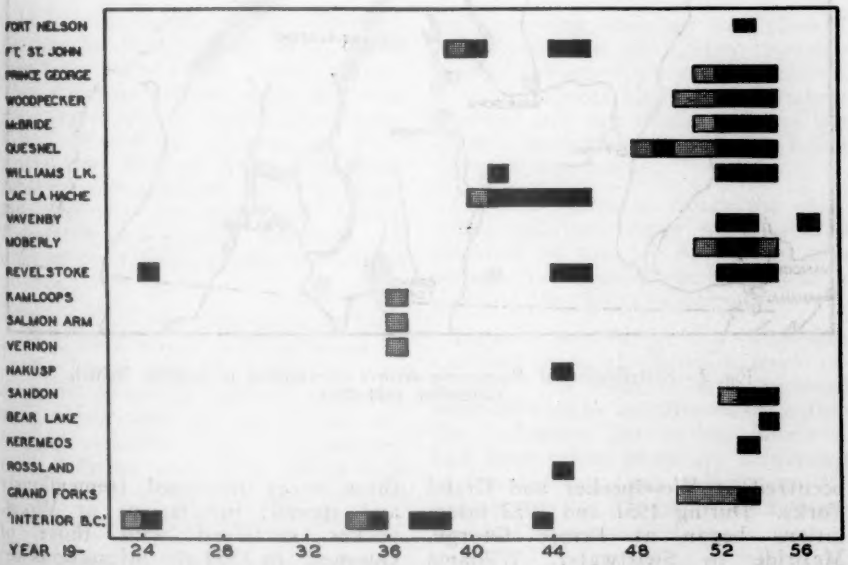

Fig. 1.—Records of occurrence of *Malacosoma disstria* infestations in interior British Columbia from 1923 to 1956. Dotted bars show medium infestation; black bars indicate heavy infestation.

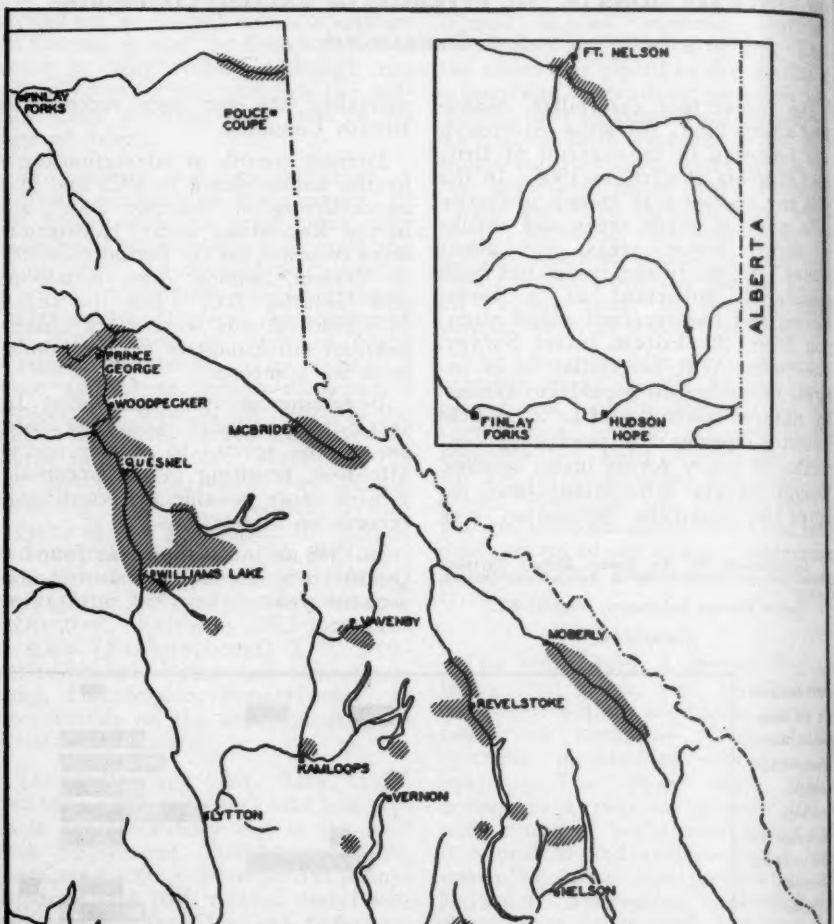

Fig. 2.—Distribution of *Malacosoma disstria* infestations in interior British Columbia, 1924-1956.

occurred at Woodpecker and Grand Forks. During 1951 and 1952 infestations began at Prince George, McBride to Swiftwater, Williams Lake, Vavenby, Moberly to Radium Junction, Revelstoke, and Sandon. By 1953 the caterpillar populations in these areas increased tremendously and spread; infestations at Woodpecker coalesced with those of Quesnel. In 1954 the infestations remained at a high level and continued to spread and coalesce so that a continuous line of infestation occurred

from Salmon Valley north of Prince George, to Williams Lake; the Vavenby and Grand Forks infestations disappeared. Infestations were discovered at Fort Nelson and Keremeos in 1953 and at Bear Lake (near Kelowna) in 1954, but these subsided. In 1955 no infestations or traces of *M. disstria* were found except at Summit Lake near Nakusp where larvae were present until they succumbed to disease. Only a single infestation was discovered in 1956 near Vavenby in a previously inaccessible area (see Figures 1 and 2).

M. disstria populations undergo extreme fluctuations as is suggested by the chart in Fig. 1. Baird (1920) mentions that records (1790-1920) for *M. disstria* in North America indicate "years of abundance followed by years of scarcity".

It is difficult at this time to isolate factors responsible for past population collapses. Sufficient evidence is not available to determine the role of parasites in the past collapses. Observations in the field in some instances have shown that disease can be an important natural control factor.

References

Baird, A. B. 1920. Some notes on the tent-caterpillar. Proc. Ent. Soc. B.C. 11: 97-100.

Wellington, W. F., J. J. Fettes, K. B. Turner, R. M. Belyea. 1950. Physical and biological indicators of the development of outbreaks of the spruce budworm, *Choristoneura fumiferana* (Clem.) (Lepidoptera: Tortricidae). Can. J. Research, D, 28: 323-329.

PLANS TO ERADICATE ORIENTAL FRUIT MOTH IN THE OKANAGAN VALLEY, B.C.

W. D. TOUZEAU[1] and C. L. NEILSON[2]

In late September of 1956 cannery peaches in Summerland, B.C., were found to contain live insect larvae. These peaches had been imported from the Yakima area of Washington State, U.S.A. Specimens presented to Provincial and Federal authorities were subsequently identified by G. G. Dustan, Officer-in-Charge, Fruit Insect Laboratory, Vineland, Ontario, as oriental fruit moth, *Grapholitha molesta* (Busck.).

Infestations reported to be as high as 30% were noted in some boxes of fruit. Local cannery practices consisted of spreading cannery waste by manure spreader throughout an adjoining orchard. This was stopped and all future waste was buried in a pit. In view of the fact that little of the imported crop of peaches was left for processing, canning was allowed to continue, but all further importations of cannery fruit were prohibited. It would appear that the infestation occurred only in a small portion of the imports, as further examination failed to reveal any larvae.

Cannery boxes in which the shipments had been made were ordered returned to the U.S.A. There was some delay in action which finally took place on the threat of burning.

Import records at the Canadian Customs port of Osoyoos were reviewed. All loads of fruit received were covered by certificates indicating that adequate fumigation measures had been taken from the standpoint of temperature, time, and dosage. No explanation for the failure of fumigation has been provided.

Enquiries were made on the exact origin of the specific load of fruit first found to be heavily infested. The

1. Officer-in-Charge, Plant Protection Division, Production Service, Canada Agriculture, Vancouver, B.C.

2. Provincial Entomologist, Province of British Columbia, Vernon, B.C.

orchard from which this fruit originated was said to be in the fringe area of the known infested area in Yakima. This orchard had not been trapped but traps in adjoining orchards had caught no moths in the past two seasons. There had been no local reports of infested fruit from this orchard and the only possible sign of trouble might be associated with twig flagging, a symptom not unusual with twig borer damage.

It was learned that two canneries in the Okanagan, the York Cannery at Osoyoos and Barkwills at Summerland, had received fruit from the same area, Yakima, while a third cannery, Rowcliffe at Kelowna, had received peaches only from the Wenatchee area. The Osoyoos cannery had completed operations but the personnel had not seen any infested fruit. The Kelowna cannery was still in operation; a careful check of the stock on hand did not reveal any larvae. It was concluded that the Summerland area would have to be considered infested, as larvae had been found; the Osoyoos area possibly infested as peaches had been obtained from the same source; but the Kelowna area could be considered as not infested, as the fruit used was from another source and no infestation was found on investigation.

Federal and Provincial officials, alarmed at the finding of oriental fruit moth larvae in Summerland, decided that definite action must be taken in an endeavour to prevent this insect from becoming established in the Okanagan Valley. Consultations were held with U. S. authorities versed in oriental fruit moth and fumigation procedures. Canadian authorities concerned themselves with methods to be used in an attempt to eradicate this potential pest.

It was decided that before the 1957 growing season commenced the canneries at Osoyoos and Summerland would be completely covered with tarpaulins and fumigated with methyl bromide. The orchard adjacent to the Summerland property would be removed and burned and the land fumigated with methyl bromide. The same fumigant would be used on the fruit dump at Osoyoos and the hillside adjoining the cannery at Summerland. The ripening rooms of both canneries would receive a fall fumigation. Spring and summer spraying of host plants of the oriental fruit moth would be undertaken in the areas adjacent to the canneries, and compensation would be arranged for fruit unfit for human consumption due to excessive DDT residue. Insect traps would be placed on the fumigated buildings and in an area beyond a one-mile radius, as well as spot trapping from the International Boundary to Summerland.

It is hoped that this combined Provincial-Federal action will forestall the establishment of oriental fruit moth in the Okanagan Valley. Should this insect become established and prove to be of economic importance, it could cost the tree fruit industry some $200,000.00 a year. An estimated investment of $65,000.00 attempting eradication was considered well worth while.

Royal Jelly, the New Elixir

Last winter the School of Domestic Science asked me where a supply of royal jelly could be obtained. Apparently the School of Physical Education was seeking it to feed to the basketball team to enable them to win games. I applied to Hugh B. Leech of the California Academy of Sciences who sent me the addresses of two firms who supply royal jelly in retail or wholesale lots.

Fabulous claims are made for it. For a mere $60.00 you can obtain a month's supply to enable you to accomplish almost anything, physically or mentally. As might be expected, the amounts required for these miracles, are very small indeed. The latest use for it is in cosmetics; as a skin food, one application will remove wrinkles for 24 hours and for a mere $10.00 one can become young again.—*G. J. Spencer, Dept of Zoology, University of British Columbia.*

SPECIES OF ROOT MAGGOTS (DIPTERA: ANTHOMYIIDAE) OF CRUCIFEROUS CROPS IN BRITISH COLUMBIA[1]

A. R. FORBES[2] AND D. G. FINLAYSON[3]

Several species of root maggots occur separately or in mixed populations in cruciferous crops in Canada (Matthewman *et al.*, 1950, Brooks 1951, Oughton 1952, and Pond 1956). The composition of these populations varies seasonally and geographically, and, since each species differs in habits, life history, and economic significance it is important to know which ones occur on a crop.

When a primary, phytophagous species attacks a root, the damage frequently attracts phytosaprophagous species and, as decay progresses, additional saprophagous species, predators, and parasites are attracted to the root. A complicated ecological succession is started by the original attack, especially in rutabagas (swede turnips), which have a long growing period and large, fleshy roots.

These facts make analyses of field populations prerequisite to root maggot studies and particularly to control tests.

Root maggots were collected from cruciferous crops in British Columbia from 1948 to 1956. This paper reports data from these collections, with particular reference to *Hylemya* spp. in rutabagas.

Methods

Single and periodic collections were made from various cruciferous crops at many localities throughout British Columbia. For rutabagas, several collections were made from the same fields during the growing season for four years at Courtenay, three years at Victoria, two years at Alberni, and one year at Tappen and Salmon Arm. The same farms at Courtenay, Victoria and Alberni were used each year. The maggots were generally collected from 30 roots taken at random from portions of the fields not treated with insecticide. The roots were carefully dissected and all maggots found were removed and preserved. The maggots were later identified with Brooks' key (Brooks 1951).

Larvae and puparia for rearing were collected from roots of cruciferous crops at Agassiz, Cloverdale, Kamloops, Kelowna, Ladner, Milner, Tappen and Victoria. The adults were identified by officers of the Entomology Division, Ottawa. Records of adults in the Canadian National Collection of Insects were also obtained.

One hundred and seven collections of maggots were made and identified from cultivated crucifers during the eight years 1949 - 1956 (Table I). Most of these were from rutabagas, but one or more collections were made from each of cabbage, radish, turnip, cauliflower and broccoli. The collections were from all the major agricultural areas in the Province except the Peace River area (Table II).

Species Found

Larvae of four species of *Hylemya* were found: the cabbage maggot, *H. brassicae* (Bouché); the seed-corn maggot, *H. cilicrura* (Rond.); the turnip maggot, *H. floralis* (Fall.); and *H. fugax* (Meig.).

Of 395 flies of the genus *Hylemya* reared from larvae from cabbage, radish, rutabagas, and brussels sprouts from eight localities, 78 per cent were of *brassicae*, 17 per cent were of *cilicrura*, 5 per cent were of *fugax*, and 0.2 per cent were of *planipalpis* (Stein).

---

1. Contribution No. 3641, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Associate Entomologist, Field Crop Insect Section, Entomology Laboratory, Vancouver, B.C.
3. Associate Entomologist, Crop Insect Section, Entomology Laboratory, Kamloops, B.C.

Since larvae of *planipalpis* and *brassicae* cannot be separated satisfactorily by Brooks' key, a few of the larvae reported as of *brassicae* might be of *planipalpis*. Identifications of adults, however, showed that this error was very small. Similarly, a few of the larvae given as of *cilicrura* might be of *liturata* (Meig.) (=*trichodactyla* (Rond.)). No adults of *liturata* were reared from crucifers but the species was reared by Mr. J. H. McLeod, now of the Entomology Laboratory, Belleville, Ontario, from bean roots at Vancouver. It occurs elsewhere in Canada on cultivated crucifers.

The cabbage maggot is the most common and most widely distributed root maggot in British Columbia (Tables I and II). It was the most abundant species throughout the growing seasons (Table III) and constituted 82 per cent of the total *Hylemya* maggots collected. It is the most serious pest of cultivated crucifers in the province. Up to 90 per cent of the plants of untreated early stem brassica crops have been killed by the maggots (Kings *et al.* 1957), and approximately 80 per cent of untreated rutabagas are frequently rendered unmarketable because of maggot damage (King and Forbes 1954).

TABLE I.—Numbers of larvae of various species of *Hylemya* collected from various cruciferous crops in British Columbia, 1949 - 1956.

Crop	Number of collections	*brassicae*	*cilicrura*	*floralis*	*fugax*	Total
Cabbage	5	804	12	0	3	819
Cauliflower	2	78	1	0	0	79
Broccoli	1	0	1	23	0	24
Radish	4	185	4	0	0	189
Rutabaga	93	3190	761	140	3	4094
Turnip	2	39	0	0	0	39
Total	107	4296	779	163	6	5244
% of grand total	—	81.9	14.9	3.1	0.1	—

The seed-corn maggot is also generally distributed in British Columbia. It formed 2 per cent of the *Hylemya* larvae collected from cabbages and 18.6 per cent of those from rutabagas (Table I). It became increasingly common in rutabagas as the seasons progressed until it constituted about 20 per cent of the total maggots in the roots. The larvae always occurred in association with *brassicae* or *floralis* larvae, or both, so that there was no evidence that they caused primary root damage. In coastal British Columbia during backward spring weather, the seed-corn maggot is often a fairly serious pest on sprouting seeds, especially beans and peas.

The turnip maggot was collected from rutabagas at Courtenay, Prince George and Smithers and from broccoli at Prince George. Records of the adults include one as far north as Atlin. It is significant that in Alaska the turnip maggot is the most important and widely distributed root maggot whereas the cabbage maggot has not been recorded (Washburn 1953, p. 3). In British Columbia it was taken only during August and September (Table III). At Courtenay, where periodic collections were made from rutabagas, *floralis* occurred on the roots during August and early September each year, sometimes being more abundant than *brassicae*. In north-central British Columbia *floralis*

TABLE II.—Localities in which larvae and adults of six species of *Hylemya* were found in British Columbia.

Species	Localities
brassicae (Bouché)	Larvae: Agassiz, Alberni, Armstrong, Barnhartvale, Cloverdale, Comox, Courtenay, Cranbrook, Creston, Grand Forks, Honeymoon Bay, Kamloops, Kelowna, Lavington, Ladner, Milner, Penticton, Quesnel, Smithers, Sullivan Station, Salmon Arm, Tappen, Thrums, Vancouver, Victoria.
	Adults: Agassiz, Armstrong, Cloverdale, Cultus Lake, Duncan, Essondale, Hazelton, Kamloops, Kelowna, Ladner, Milner, Pacific, Port Hammond, Robson, Saanich, Sicamous, Tappen, Vancouver, Vernon, Victoria.
cilicrura (Rond.)	Larvae: Alberni, Cloverdale, Comox, Courtenay, Grand Forks, Honeymoon Bay, Kamloops, Kelowna, Ladner, Prince George, Quesnel, Salmon Arm, Sullivan Station, Tappen, Victoria.
	Adults: Agassiz, Cloverdale, Cultus Lake, Hedley, Kelowna, Keremeos, Ladner, Milner, Naramata, Nicola, Oliver, Robson, Salmon Arm, Summerland, Tappen, Vancouver, Vernon, Victoria.
floralis (Fall.)	Larvae: Courtenay Prince George, Smithers.
	Adults: Armstrong, Atlin, Invermere.
fugax (Meig.)	Larvae: Armstrong, Quesnel, Victoria.
	Adults: Agassiz, Kamloops, Robson, Cultus Lake.
planipalpis (Stein)	Adults: Milner, Victoria.
liturata (Meig.)	Adult: Vancouver.

caused severe damage to rutabagas and broccoli in August, 1954.

The maggot *H. fugax* constituted only 0.1 per cent of the *Hylemya* larvae collected. It occurred in cabbage at Quesnel and in rutabagas at Armstrong and Victoria. Adults were reared from maggots from brussels sprouts at Agassiz and from radish at Kamloops.

A single fly of *H. planipalpis* was reared from a maggot collected from rutabaga at Milner in 1950. An adult of this species was taken at Victoria on July 2, 1918, by Mr. W. Downes, formerly of the Fruit Insect Laboratory, Victoria, British Columbia. It is a major pest of radish in the Prairie Provinces (Brooks 1951).

TABLE III.—Numbers of *Hylemya* larvae collected from cruciferous crops in British Columbia, by months, 1949 - 1956.

Species	June	July	August	September	October	November
brassicae (Bouché)	806	422	873	784	1331	80
cilicrura (Rond.)	16	42	262	195	263	1
floralis (Fall.)			138	25		
fugax (Meig.)					6	
Total	822	464	1273	1004	1600	81

Other maggots collected in small numbers from roots of rutabagas included: *Dolichopus* sp., *Fannia canicularis* (L.), *Lonchaea vaginalis* Fall., *Muscina assimilis* (Fall.), *Oscinella* sp. (coxendix group), *Eumerus strigatus* (Fall.), *Sciara* sp., and a phorid. The maggots *Fannia canicularis* and *Muscina assimilis* were very common on roots of cabbages infected with clubroot that had begun to decay.

Adults of *Coenosia tigrina* (Fall.), a dipterous predator first reported in Canada from Quebec (Perron and Lafrance 1952), were reared from immature stages from rutabagas at Tappen, B.C., in 1950.

Summary

Root maggots collected during 8 years from cruciferous crops in British Columbia were mostly the cabbage maggot, *Hylemya brassicae* (Bouché). The seed-corn maggot, *H. cilicrura* (Rond.) occurred frequently and the turnip maggot, *H. floralis* (Fall.) was found only during August and September at Courtenay, Prince George and Smithers. *H. fugax* (Meig.) was collected in small numbers. A single adult of *H. planipalpis* (Stein) was reared from a maggot collected from rutabaga at Milner. *H. liturata* (Meig.) was not found in crucifers, but did occur in bean roots at Vancouver. *H. brassicae* and *H. floralis* caused primary root damage. On rutabagas, *H. cilicrura* occurred only in association with *brassicae* or *floralis*, or both.

Acknowledgments

The authors are grateful to Mr. A. R. Brooks, Entomology Laboratory, Saskatoon, Sask., for identifying the maggots of the initial collections; to Mr. M. D. Noble, entomology Laboratory, Vancouver, B.C., for his help in collecting maggots; and to the various officers of the Entomology Laboratories at Agassiz, Kamloops, Vancouver and Victoria for their collections of maggots.

References

Brooks, A. R. Identification of the root maggots (Diptera: Anthomyiidae) attacking cruciferous garden crops in Canada, with notes on biology and control. Can. Ent. 83: 109-120. 1951.

King, K. M., and A. R. Forbes. Control of root maggots in rutabagas. J. Econ. Ent. 47: 607-615. 1954.

King, K. M., A. R. Forbes, and M. D. Noble. Chemical control of root maggots in early cabbage. Proc. Ent. Soc. British Columbia 53: 28-34. 1957.

Matthewman, W. G., A. W. Rathwell, and J. P. Lachaine. Notes on the species of root maggots damaging onions, cabbage and radish at Ottawa in 1948. Can. Ent. 82: 12-16. 1950.

Oughton, J. A study of turnip root maggots in Ontario. 82nd Ann. Rept. Ent. Soc. Ont., 1951, pp. 77-84. 1952.

Perron, J. P. and J. Lafrance. A note on a dipterous predator of the onion maggot, *Hylemya antiqua* (Meig.). Can. Ent. 84: 112. 1952.

Pond, D. D. Annotated list of insects found in or near roots of cultivated crucifers in New Brunswick. J. Econ. Ent. 49: 336-338. 1956.

Washburn, R. H. Roots maggots in Alaska. Univ. Alaska, Alaska Agr. Expt. Sta. Circ. 19. 1953.

ON THE ACRIDIOPHAGOUS SARCOPHAGIDAE OF BRITISH COLUMBIA WITH RECORDS OF ALL OTHERS TAKEN IN THE PROVINCE

G. J. SPENCER[1] AND E. R. BUCKELL[2]

Introduction

In 1934 Howard Curran (4) proposed the name Metopiidae, to include in the family "all the flies previously known as Sarcophagidae, part of the Muscidae and part of the Tachinidae of Williston's Manual, which is apparently a natural association as proved by a study of larval and pupal characters."

The larvae of the Metopiidae are either scavengers or flesh feeders, parasitic chiefly on invertebrates, especially insects. A few are sometimes myiasis-producers on vertebrates. Apparently all the members of the old family Sarcophagidae are larviparous but within the family Metopiidae as now constituted, there is, even in this Province, a nice gradation in methods of reproduction from truly larviparous flies to those that lay eggs which hatch almost the instant they are extruded, others the eggs of which hatch within 10 seconds or so, and yet others the eggs of which may require as long as 24 hours to hatch. All the maggots of the Sarcophagidae *sens. strict.* have the posterior spiracles situated within a deep depression. For the most part, the flies have two silvery-grey stripes and three black stripes on the thorax and have tesselated abdomens; the antennal arista is plumose above and below for only half of its length, and the vein M_1 bends strongly forward towards R_5, although the apical cell is almost always open.

The classification of the Metopiidae, as Curran says, is in a chaotic condition because "a great many genera have been proposed upon characters possessed by one sex or the other and upon characters which are apparently of not more than specific or group value, which are found to be entirely unsatisfactory when large collections are studied." Townsend especially has produced a bewildering array of generic names: in the 54 species with which we are concerned in this paper, he has proposed 16 new genera — all ignored by Curran (4), and Brues, Melander and Carpenter (2). Curran's family Metopiidae now includes such well-known but diverse forms as the common blue and green blowflies, the black blowflies that attack sheep, those that parasitize nestling birds, the cluster fly that attacks earthworms, and the true Sarcophagidae. For the sake of simplicity we are using here the nomenclature of Aldrich (1) with a few more recent changes but indicating in brackets Townsend's generic grouping and nomenclature.

The habits of attack of these Sarcophagidae vary from those of *Wohlfahrtia vigil* and *W. meigenii* (*Paraphyto opaca*) which larviposit on the very young of wild and caged mammals such as mink, and sometimes on babies; *Sarcophaga citellivora* which attacks ground squirrels; *S. magna* which attacks the western striped June beetle *Polyphylla perversa; S. eleodis* which attacks the large black darkling beetles; *Agria affinis* and *S. tuberosa sarracenioides* which parasitize caterpillars of butterflies and moths, including the spruce budworm; to *S. l'herminieri* which develops in carrion and dung, chiefly cow manure, the commonest and most widespread species in this Province and most of the northern part of the continent (1).

This paper is based on British Columbia records of Sarcophagidae from the Canadian National Collection at Ottawa, the collections at the University in Vancouver, the Dominion Entomological Laboratory at Kamloops, and from literature (3) (5) (7).

1. Professor Emeritus, Department of Zoology, University of British Columbia.
2. Retired, at Salmon Arm, B.C., formerly Officer-in-Charge, Entomology Laboratory, Kamloops.

The field observations, rearing experiments, identifications, records of distribution and writing of this paper, were done by G. J. Spencer, and the mass cage rearing, making of the Kamloops collection and preliminary lists of Sarcophagidae, by E. R. Buckell (3).

Some of this material was presented in a paper entitled: "The natural control complex affecting grasshoppers in the dry belt of British Columbia", to the 10th International Congress of Entomology, at Montreal, August 1956.

BRITISH COLUMBIA RECORDS OF SARCOPHAGIDAE TO APRIL 1957

Emblemasoma erro Ald.

Wohlfahrtia vigil Walk. Iden. H. J. Reinhard. Quesnel. Rare.

Paraphyto opaca Coq. (*W. meigenii* Schiner). Nicola, Kamloops, Vernon, Chilliwack, Vancouver.

Brachycoma devia Fall.

B. sarcophagina Towns.

Agria (*Pseudosarcophaga* Kramer) *affinis* Fall. Monashee, Robson, Salmon Arm, Lumby, Vancouver.

Sarcofahrtia ravinia Park. (*Thelodiscus indivisus* Ald.) Chase. Rare.

Senotainia flavicornis Towns. Chase, Kamloops. Rare.

Blaesoxiphotheca (*Sarcophaga* Meig.) *coloradensis* Ald. Common at Kamloops in 1954 when most other species were absent; Chilcotin.

B. caudata Towns. Females abundant at Lytton in 1931 "not referable to species without males" (D. G. Hall).

Acanthodotheca Towns. 2 spp. undet. of this genus from B.C. in C.N.C.

Helicobia rapax Walk. (*Sarcophaga helicis* Towns. Ald.) The prevailing fly attacking *M. bilituratus* at Lytton in 1931; one of the earliest sarcophagids of the season. Nicola, Kamloops, Lytton, Robson. Reared also from the longicorn *Ergates spiculatus* Lec. at Kamloops.

Metoposarcophaga importuna Walk.

Ravinia pusiola (Van der Wulp). Robson.

R. stimulans (Walk.) (*quadrisetosa* Coq.). Robson.

Sarcophaga (*Sarcotachinella* Towns.) *sinuata* Meig. Lytton, Kamloops, Robson, Skidegate.

S. (*Boettcheria* Park.) *latisterna* Park. Vancouver.

S. (*Boettcheria* Park.) *cimbicis* Towns. Quesnel, Kamloops.

S. (*Boettcheria* Park.) n. sp. near *latisterna* (Det. Curran) in C.N.C. Seven places in B.C.

S. (*Fletcherimyia* Towns.) *fletcheri* Ald. Robson.

S. (*Tephromyiella* Towns.) *atlanis* Ald. Kamloops, Stump Lake, Nicola, Robson.

S. (*Protodexia* Towns.) *hunteri* Hough. The prevailing gropper parasite in 1954 at Kamloops; Lytton, Robson.

S. (*Stenaulacotheca* Town.) *spatulata* Ald.

S. (*Opsophyto* Towns.) *opifera* Coq. The most abundant sarcophagid in the dry belt; Kamloops, Nicola, Chase, Vernon, Lytton.

S. (*Eleodiomyia* Towns.) *eleodis* Ald. Kamloops, Robson.

S. (*Kellymyia* Towns.) *kellyi* Ald. Irregular in occurrence but abundant when present. Lytton, Kamloops, Kelowna, Nicola, Robson.

S. (*Zygastropyga* Towns.) *sulculata* Ald. Vancouver, Kamloops. Very rare.

S. (*Bercaeopsis* Towns.) *wrangeliensis* Park.

S. (*Bercaeopsis* Towns.) *vancouverensis* Park.

S. (*Acridiophaga* Towns.) *setigera* Ald. B.C.-Alberta boundary.

S. (*Acridiophaga* Towns.) *falciformis* Ald. Kamloops, Robson.

S. (*Acridiophaga* Towns.) *savoryi* Park.

S. (*Acridiophaga* Towns.) *aspertella* Park.

S. (*Acridiophaga* Towns.) (*Metoposarcophaga*) *tothilli* Park.

S. (*Metoposarcophaga*) *incurva* Ald. Robson.

S. (*Robineauella* End.) *juliaetta* Ald. Shuswap Narrows. Very rare.

S. (*Robineauella* End.) *occidentalis* Ald. Vancouver. Rare.

S. (*Robineauella* End.) *tuberosa* var. *exuberans* Pand. Nicola, Kamloops, Robson. Uncommon.

S. (*Robineauella* End.) *tuberosa* var. *sarraceniodes* Ald. Lytton, Kamloops.

S. (*Robineauella* End.) *tuberosa* var. *harpax* Pand. Lytton, Nicola, Kamloops, Hat Creek, Chilcotin, Alexandria. Common.

S. (*Robineauella* End.) *nearctica* Park. (*scoparia* Pand.). Vancouver, Kamloops, Robson. Scarce.

S. (*Robineauella* End.) *bullata* Park. Kamloops, Vancouver.

S. (*Robineauella* End.) *cooleyi* Park. Chilcotin, Robson. Very rare.

S. plinthopyga wiedmann (*robusta* Ald.). Reared in Vancouver from mammal skulls sent from Mexico. There is a specimen from Seattle in U.S.N.M. (Aldrich) so it may occur naturally in B.C. also.

S. insurgens Ald. Kamloops, Chase. Scarce.

S. magna Ald.

S. haemorrhoidalis Fall. Vancouver. Rare.

S. thatuna Ald. Nanaimo. Rare.

S. (*Miltoravinia* Towns.) *planifrons* Ald. Kamloops, Nicola.

S. (Euravinia Towns.) *l'herminieri* Robineau-Desvoidy. Widespread and common; Kamloops, Nicola, Robson, Cariboo, Vancouver.

S. (Chaetoravinia Towns) *latisetosa* Park.

S. (Acridiophaga Towns.) *reversa* Ald. Very common at Kamloops, merely occurs in the Nicola.

S. (Acridiophaga Towns.) *uncata* Van der Wulp (*marginata* Ald.) Kamloops. Rare.

S. (Acridiophaga Towns.) *caridei* Brethés (*angustifrons* Ald.). Kamloops. Rare.

S. (Acridiophaga Towns.) *aculeata* Ald. Lytton, Kamloops. Scarce.

S. (Acridiophaga Towns.) *aculeata* var. *taediosa* Ald. The prevailing variety of *aculeata* in B.C. Kamloops.

S. (Acridiophaga Towns.) *aculeata* var. *gavia* Ald. Kamloops. Rare.

S. (Acridiophaga Towns.) *aculeata* var. unplaced because no males; very many females; Kamloops, Pritchard, Trap Lake, Midway.

Of these 54 identified species, all but the following 13 in the Canadian National Collection are represented in the collections at the University of British Columbia. Most of the University specimens were collected by G. J. Spencer: *Sarcophaga aspertella, Brachycoma devia, Blaesoxiphotheca caudata, Emblemasoma erro, Metoposarcophaga importuna, S. magna, S. occidentalis, Ravinia pusiola, Brachycoma sarcophagina, S. savoryi, S. tothilli, S. vancouverensis, S. wrageliensis.*

Biology

In connection with the grasshopper parasites some terms should be defined. A grasshopper is a member of the family Acridiidae, or short-horned, jumping Orthoptera; a hopper is the flightless nymph of a grasshopper; a locust is a short-horned grasshopper which regularly, or irregularly, congregates and migrates in a swarm (8). To indicate an orthopteroid population of any combination of flying adults and flightless nymphs of several to many species, I propose, and will employ the term "gropper". There are no true locusts in this Province in normal years, but one species, *Melanoplus bilituratus* (Walker), hitherto (6) called *Melanoplus mexicanus mexicanus* (Saussure), remains a localized grasshopper for 7 to 9 years and then increases to outbreak proportions. At such times the species may undertake locust-like mass flights for short distances, or for several to many miles. Apparently *M. bilituratus* is closely related to *M. spretus* Walsh, the notorious Rocky Mountain locust, a long-winged race which arose on the eastern slopes of the Rockies and migrated eastwards as far as the valley of the Mississippi from 1868 to about 1870. *M. bilituratus* is widespread in B.C., but becomes a serious pest periodically and only in the dry belt (7).

Another even more widespread acridiid is *Camnula pellucida* Scudder, the roadside grasshopper, which also develops to outbreak proportions but never becomes a locust, although it may scatter for wide distances from its developmental centres (7).

Practically all our parasite work has concerned these two species, especially the relationship of the sarcophagids to *M. bilituratus*. Of the 54 species of flies listed, the developmental habits of 27 are unknown, 14 have been bred from groppers at Lytton or Kamloops, and two species recorded elsewhere in North America as gropper parasites have been captured by us locally but not reared. One of the latter pair, *Acridiophaga caridei* is of particular interest. It is generally present in Argentina and Uruguay as a parasite of the gregarious locust *Schistocerca paranensis* Burmeister. From both these countries collections of larvae have been made by British workers and sent for colonization to the parasite laboratory at Belleville, Ontario. Canadian workers have reported that this is a very active and agressive fly, most suitable for building up populations under laboratory conditions. Many specimens have been liberated in Ontario. As far as our experts can tell, the identical species is found in this Province. We have captured a few specimens in the field near Kamloops but have never recovered *A. caridei* from the many thousands of groppers we have caged.

The 14 species or varieties which we have reared from groppers captured alive in the field and maintained in

large rearing cages for parasite recovery, are: — *Blaesoxiphotheca coloradensis, Helicobia rapax, Sarcophaga sinuata, S. aculeata, S. aculeata* var. *gavia, S. aculeata,* var. indeterminable, *S. falciformis, S. reversa, S. kellyi, S. tuberosa* var. *exuberans, S. tuberosa* var. *sarracenioides, S. tuberosa* var. *harpax, S. opifera, S. hunteri.*

On the hills of the dry belt, 16 species including these 14, may be found in some seasons. All of them have certain habits in common as we have determined repeatedly by experiments conducted from 1931 to 1946 and in 1954. The flies occur unpredictably, abundant one day and absent the next, turning up suddenly in an area where they have never been taken previously, occurring in countless thousands in an area in the autumn and absent next spring; literally, they occur where you happen to find them.

Speaking of the 14 acridiophagous species as a group, the following summarizes the habits that these flies have in common:

1. Groppers in the dry belt of British Columbia follow a fairly regular 7- to 9-year cycle of abundance and recession. In any area subject to attack by *M. bilituratus,* unless the cycle has been upset by control measures, the course of the cycle can be determined by the presence or absence of parasitic flies, and by comparing the relative numbers of hosts and parasites. An infestation with few or no associated parasites, is on the increase, and where parasites are abundant the host is in peak numbers, probably near the top of the curve or cycle, or just past it. By actual count, the proportion of flies to groppers may be 77 to 100, and in damp, grassy hollows, there may be more flies than groppers. Where this happens, in the next season the gropper population falls like a plummet.

2. All the species of sarcophagid flies concentrate upon *M. bilituratus,* our most agile, aggressive, harmful, and widely distributed gropper. There may be a dozen species of groppers present including a vast number of *pellucida,* but the highest sarcophagid parasitism obtained to date in *Camnula* has been only 6 per cent, and minor species may be unparasitized; *M. bilituratus* bears the brunt of the attack.

3. Nineteen species of sarcophagids have been experimented with on gropper-infested areas, 5 species not being parasites, and in *all* of them there exists an impulse activated apparently by visual stimulus, to pursue a small moving object. This was first determined in 1931 when the flies darted at inch-long pieces of alfalfa stems flicked with thumb and finger over them. Later on bits of wood the size of a gropper body were used but it was soon discovered that such shape and size were not essential in evoking the impulse; the flies would pursue small pebbles or even rolled-up pieces of paper. The impulse occurs in both sexes, but in the case of males, it is probably a sex urge for in the early part of the season when male flies only are present in an area, they will dart at everything within their range of vision.

4. The flies sit on objects just above the general ground level, such as stones or lumps of cattle and horse manure, and from these vantage points pursue groppers that jump or fly from near them. They strike the groppers from above, seemingly at the junction of thorax and abdomen between the wings, and return to the perching place. Given an even distribution of groppers, a field of stones suitable for perching places will have more flies in it than a grassy field without stones; a calm area will contain more flies than a windswept one, and the ultimate parasitism in a hollow will be much higher than in a windswept area.

In a stoneless area of short grass, infested with groppers and with considerable numbers of flies, three types of perches were tested: very dark, old burlap sacks; clean, light brown burlap sacks; and white flour sacks. These were spread at uniform distances over the sod. In a very few minutes the flies averaged 0.1 on the

dirty old sacks, 4 on the clean brown sacks, and 10 or 12, and up to 20 on the white flour sacks. From these vantage points the flies pursued passing groppers, returning to the sacks after each trip.

Anything which disturbs groppers in an area causing them to leave the ground, results in increased parasitism. Domestic animals, especially grazing sheep, cause groppers to jump or fly and the sarcophagids then parasitize them. No instance has been noted of any of these 14 species of flies larvipositing on a gropper on the ground; the host must be either jumping in the case of a nymph, or flying. During one season, in the heat of the day when groppers normally do not fly, with *pellucida* groppers present in large numbers and flies of the *aculeata* complex abundant, the flies persistently bullied and buzzed at the groppers on the ground until they were forced to fly to escape the bullying, whereupon the flies struck at them. This harassment occurred for some time that year but has never been seen since.

5. The urge to chase a moving object results in female flies impartially pursuing *all* species of groppers in an area, both large nymphs of the 4th and 5th instars and adults, whenever these occur together.

6. As far as the human eye can perceive, there is physical contact between fly and gropper and *presumably*, a living larva is deposited. This seems to occur even when a small stick is flicked over a fly watching from its perch. But flies learn fast; if a succession of sticks is flicked over with a noticeable pause between each one, the first piece is apparently hit; the second time the fly stops a few inches short of it; the third time the fly may be 2 or 3 feet short of it, or merely fly a few feet off the perch, and back again.

Certain questions arise here: Does a fly deposit a maggot every time it strikes a gropper? Since flies appear to strike groppers indiscriminately, why is *M. bilituratus* alone so heavily parasitized? Conversely, why is *C. pellucida* apparently and markedly, almost immune from these flies?

To answer the first question, flies were collected just after they had pursued and apparently "struck" a gropper. Careful examination led to several conclusions: In the early part of the season and sometimes later, the fly was a male. Sometimes the gonads of the fly were immature, indicating that the pursuing impulse was not the result of a hormone secreted only at reproductive maturity. Sometimes the reproductive system was mature with a maggot ready in the common oviduct like a torpedo in a tube; apparently the fly had struck without discharging the maggot. This happened not infrequently when groppers were very active and when flies struck repeatedly. Presumably the flies had not time to discharge their maggots before the visual impulse impelled them to attack again. Sometimes when the reproductive system was mature, the common oviduct was empty, indicating that the maggot had just been discharged. This condition occurred many times when flies were active in a swarm of groppers. The visual impulse to strike had occurred before the next maggot was in place ready for discharge. It was not possible to determine exactly how fast and at what intervals a fly could discharge a succession of maggots. Even when a fly had discharged all its maggots, sometimes it apparently followed the impulse to strike until it died. The supply that a gravid and really fat fly (*aculeata* complex) had on hand, was 120 maggots, 60 in each ovary, all the maggots of uniform and apparently mature development.

To further check this question, groppers were collected and examined immediately after being struck by flies. This was done many times but never was a maggot found *on* a gropper's body and, to judge from experiments reported here, it was unlikely that the maggot had penetrated in the few seconds it took to collect the

struck gropper. Unfortunately, the surface of the fan-like meta wings was not examined; it is possible that the maggots were deposited on the wings and left to penetrate the groppers later.

To answer the questions as to why *M. bilituratus* is particularly susceptible to attack by species of sarcophagids, and *C. pellucida* practically immune, both species of groppers were watched under attack in the field and laboratory, and experimentally struck to see if and how the maggots penetrated.

In the field, the behaviour of both *M. bilituratus* and *C. pellucida* differs according to the pressure of population, and the presence or absence of temporary migratory impulses. In dense populations there is, almost daily, a heavy local migration between feeding points. Groppers are freely attacked by flies as they get up from the ground, and sometimes the flies actually travel along with swarms out of which they have been captured by net. Under these conditions of seething populations, groppers do not seem to notice the flies at all, although the latter strike them freely.

In populations near the bottom of a cyclic curve, when groppers and flies may still be fairly numerous, both *M. bilituratus* and *C. pellucida* generally cut short their flight when struck, and pitch down, or nose-dive to the ground, and then assiduously clean their bodies as if in a conscious effort to free themselves of maggots. In the process the body is scraped with all the legs as thoroughly as a bee cleans herself, and the wings are opened and closed rapidly and then held aloft while fully open and rubbed down with the hind legs. The chances of a delicate maggot surviving such brushing seem remote. This behaviour on the part of struck groppers would tend to allow the establishment of more maggots in peak years when groppers do not pitch down and clean themselves, and fewer maggots during low populations near the bottom of the cycle when groppers take time to groom themselves.

In the laboratory, specimens of both species were immoblized, and first instar maggots were placed on their bodies. The procedure was as follows: flies were swept from vegetation in the field, treated with just enough chloroform, ether, or cyanide, to cause them to lose their balance and fall over. The abdomens of heavily gravid ones were then gently pressed with forceps and the fully formed maggots squeezed out. Sometimes pressure was not necessary and the maggots streamed out themselves. (There is a fine point at which it is possible to kill the flies and still have living maggots emerge. Once, a number of *S. kellyi* taken for pinning were cyanided and kept overnight in a salve box; next morning many small maggots were active in the box; they had consumed the contents of their mothers' bodies leaving only the body walls. When given a succession of freshly beheaded grasshoppers, they fed on these, reached maturity, pupated and emerged as flies.) When enough maggots were pressed out of a fly, they were held on a microscope slide until required, in a large drop of human saliva, which has been found a better medium than water or normal saline. Test groppers from an area of little or no parasitism were then immobilized in a row on a strip of wood by thin strips of scotch tape or adhesive, leaving exposed and readily accessible the particular portion of body needed. A maggot was picked up with the tip of a needle, or a very fine camel's hair brush wetted to a point, and placed on a selected part of the captive gropper.

Maggots of several species, chiefly *S. aculeata, S. reversa, S. kellyi,* the *S. tuberosa* trinity, *S. opifera* and *S. l'herminieri,* were placed on gropper bodies in various locations from the cervix to the anus, but not once was a maggot of any species observed to penetrate the inter-segmental membrane. The maggots were placed with only the viscous fluid from the parents' glands or without any fluid at all, or in drops of water or saliva, but none succeeded in penetrating the integument, or

the spiracles, although all made drilling movements with their minute mouth-hooks.

Only one spot on the gropper's body was readily and easily penetrated by 1st instar larvae, and that was the tympanum or auditory organ on the first abdominal segment. Most tiny maggots penetrated it in from 10 to 30 seconds, generally nearer 10 seconds. This occurred either when the maggot was placed directly on the tympanum or when it happened to cross the tympanum in the course of its wanderings. The maggot always quickly disappeared from view, the gropper seemed none the worse for the incision, and the parasite developed normally.

Many maggots have been introduced into gropper bodies by making minute incisions with sharp dissecting needles or minute scalpels, and placing the larvae in the small drops of blood which welled up from the wounds. The blood had a stimulating effect on maggots; they increased the activity of their mouth hooks and very quickly penetrated the wound. Maggots were inserted into a gropper by placing them on the stump of a freshly severed leg; but in most cases after the amputations the groppers died within a few days. Once an even hundred *S. reversa* larvae were readily introduced into 100 *C. pellucida* through abdominal incisions, but no maggots became established. Perhaps the blood of *C. pellucida* itself was hostile to the maggots, although the maggots entered the incisions readily enough. The wounds were of secondary importance to the host.

The maggots of one species of fly, *S. Pherminieri* were repelled by the blood of a gropper into which they were actually shoved several times. Even when they were inserted directly into the gropper's body cavity they quickly came out again. Finally, when placed on fresh rabbit intestines they completed their growth and emerged as adults.

Another question arises: "Do maggots kill their hosts, and if so, how?" It has been noted in many places on the dry belt ranges that, in restricted areas, flies have been so numerous as apparently to outnumber their hosts; on the face of it, it would appear that not one gropper would reach the end of the season. The only certain way of determining parasitism is to dissect the host; but dissection kills the host and, unless it is full grown, the maggot also dies. Moreover, maggots of the smaller species of flies such as *H. rapax* and *S. opifera*, may occur two and three, or as many as nine to a gropper. Maggots of larger flies need one gropper apiece for their development.

If one maggot of a small fly like *S. opifera* should occur in a large, fat female *C. pellucida*, it does not necessarily kill the host. On one occasion a *Camnula* was watched while she laid an egg pod; immediately after a maggot emerged from her abdomen while the gropper hopped normally away. The fly was reared and turned out to be *S. opifera*.

We have seen that the hazards the tiny sarcophagid maggots have to pass before they can enter a gropper are considerable. Granted that one has safely entered a host — what happens? To answer this question, a long series of groppers were dissected and records kept of the condition of their body contents. For most of its growth period a larva apparently feeds on blood alone, then the fat body diminishes first through being starved, and later, apparently, by being consumed. In some cases the fat body remains intact but as a starved, thin membrane, and in this condition it is easily overlooked. Also at first examination, it would appear that the female reproductive organs are consumed, but again, careful examination shows them, apparently undeveloped and juvenile, but in reality, starved in a bloodless body cavity almost to the point of absorption. The ovarioles are present, but so small as to be easily overlooked. Often at this stage,

the maggot emerges from the bloodless host, which soon succumbs. The maggots of larger flies, however, such as the *Blaesoxiphotheca* and *S. tuberosa* groups, requare the entire contents of the hosts, and when they emerge, the bodies of the hoppers are mere shells, and one can literally whistle through them.

Apart from the academic interest of this whole problem which has been condensed here almost to the point of detached statements, the practical application of the matter lies in these questions: If these Sarcophagid flies kill groppers readily and *sufficiently* to prevent cyclic increase, can the flies be reared in a parasite laboratory, kept in cold storage, and liberated where necessary to control a similar outbreak? Can we utilize them in the same way as some hymenopterous parasites are utilized?

Omitting the details of other experiments we can conclude: Of the groppers in British Columbia subject to periodic, cyclic increase, *M. bilituratus* is the only species which is very heavily attacked by 14 species of sarcophagids. Of these 14 species of flies, *S. kellyi* alone can be reared to maturity from expressed first instar maggots on a succession of immobolized or partly crushed groppers. The maggots can be fed fresh, beheaded hopper bodies daily or every other day, will readily complete their growth as maggots and will pupate; the pupae can be stored over winter. This is virtually a saprophagous trait as Mr. R. W. Smith found in the parasite laboratory in Belleville, Ontario, (personal communication) and yet in British Columbia, *S. kellyi* has sometimes proved a most aggressive and successful field parasite against outbreaks of *M. bilituratus*.

Acknowledgments

For records from the Canadian National Collection we are indebted to Mr. G. E. Shewell, Division of Entomology, Ottawa, who transcribed them and sent us the Townsend nomenclature. Mr. A. R. Brooks of the Entomological Laboratory at Saskatoon checked some identifications, and Dr. D. G. Hall, formerly of the U. S. National Museum, named the flies reared from grasshoppers at Lytton in 1931. To these specialists we extend our cordial thanks. We are grateful to Dr. R. H. Handford in charge of the laboratory at Kamloops, and to Dr. A. P. Arnason, Chief of the Crop Insect Unit at Ottawa, for permission to publish the sections of these records obtained during studies on the grasshoppers of this Province and finally, to the University of British Columbia which made a research grant to the senior author to enable him to continue the work at Kamloops in 1954.

References

1. Aldrich, J. M. 1916. Sarcophaga and Allies. Ent. Soc. of America.
2. Brues, C. T., A. L. Melander, and F. M. Carpenter, 1954. Classification of Insects. Bull. Mus. Comp. Zool. Harvard. 108: 1-917.
3. Buckell, E. R. and G. J. Spencer, 1945. A preliminary list of the flesh flies of British Columbia. Proc. Ent. Soc. B.C. 42: 6.
4. Curran, C. H. 1934. The Families and Genera of North American Diptera. Am. Mus. Nat. Hist. New York.
5. Foxlee, H. R. 1957. Diptera taken at Robson, B.C. Proc. Ent. Soc. B.C. 53: 34-39.
6. Handford, R. H. and C. L. Neilson. 1957. *in* Can. Insect Pest Rev. **35** (1): 12 (footnote).
7. Treherne, R. C. and E. R. Buckell. 1924. Grasshoppers of British Columbia. Bull. Dept. Agric. Canada; Ent. Series No. 39.
8. Uvarov, B. P. 1928. Locusts and Grasshoppers. London, Imp. Inst. of Ent.

A BRIEF HISTORY OF OUTBREAKS OF THE DOUGLAS-FIR TUSSOCK MOTH, *HEMEROCAMPA PSEUDOTSUGATA* McD., IN BRITISH COLUMBIA[1]

B. A. SUGDEN[2]

The Douglas-fir tussock moth was first reported defoliating Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco, near Chase in 1916. In 1921 the type specimens were obtained from this locality and described by McDunnough as a new species, *Hemerocampa pseudotsugata*. Prior to this the species was referred to as *Hemerocampa vetusta* form *gulosa* Hy. Edw. Since 1916 outbreaks have recurred at intervals in British Columbia, usually in semi-arid Douglas fir or Douglas-fir — ponderosa-pine forests. Severe infestation has resulted in top killing or complete tree mortality. The following notes on outbreaks of Douglas-fir tussock moth were compiled from the files of the Forest Biology Laboratory at Vernon.

HISTORY OF OUTBREAKS

1916—The Douglas-fir tussock moth was causing some damage to Douglas fir growing in and near Chase[3].

1917—A small but severe infestation occurred at Hedley. The tussock moth continued to kill Douglas fir and some ponderosa pine trees in the vicinity of Chase[3].

1918—The Douglas-fir tussock moth remained active near Chase and Hedley; also minor outbreaks were reported at Salmon Arm and Armstrong.

1919—Infestations continued at Chase and Armstrong with new outbreaks at Vernon and Kamloops. Defoliation of Douglas fir was severe; the ponderosa pine foliage was damaged where the preferred host, fir, had been completely defoliated.

1920—The insect remained active between Vernon and Kelowna and in the marginal fir stands in the vicinity of Kamloops. A population decline occurred in the other infestations.

1921—Infestations remained active from Chase west to Kamloops and from Vernon south to Kelowna. Entirely defoliated trees had died; reproduction, saplings, and pole-sized Douglas fir trees suffered the highest mortality. Heavy defoliation of the mature or semi-mature fir often resulted in the death of the upper third of the crown.

1922—A large population hatched in the spring, but the larvae died before maturing, thus bringing the infestation to an abrupt end.

1928—No further activity was described until 1928 when two infestations developed, one near Kamloops and the other near Vernon. These outbreaks were in Douglas fir growing adjacent to ranch buildings.

1929—Outbreaks were reported from Chase, Little Shuswap Lake, Cascade, and Kettle Valley districts. Greatest damage occurred in Sullivan Valley where young Douglas fir and ponderosa pine trees on 100 acres were killed.

1930—The Douglas-fir tussock moth outbreaks remained active. They ranged in size from less than an acre to 1,000 acres. Reports indicated that there was damage near Chase, Grand Forks, Kettle Valley, south from Adams Lake to Squilax, between Haywood's Corner and Deep Creek, North Thompson Valley in the vicinity of McLure and Sullivan Creek, along Paul Lake road bordering Niskonlith Forest Reserve, in the marginal Douglas fir south of the South Thompson River and in the BX District northeast of Vernon.

1931—The infestations reported during 1930 persisted and many increased in size. Also, larvae were noted defoliating Douglas fir near Okanagan Landing.

1932—The population subsided throughout the areas of infestation.

1936—After an interval of four years, small outbreaks occurred in Douglas-fir trees near farm buildings in the Armstrong and Salmon Arm districts.

1937—Additional outbreaks appeared in groups of Douglas-fir trees about farm buildings near Armstrong. Small infestations occurred at Vernon.

1938—The infestations at Vernon and Armstrong increased a little in extent but no new outbreaks were reported.

---

1. Contribution No. 401, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Forest Biology Laboratory, Vernon, B.C.
3. The Agricultural Gazette of Canada, Vol. 6, No. 2, February, 1919. Notes on the Tussock Moth, Hemerocampa vetusta gulosa Hy Edw., by W. B. Anderson.

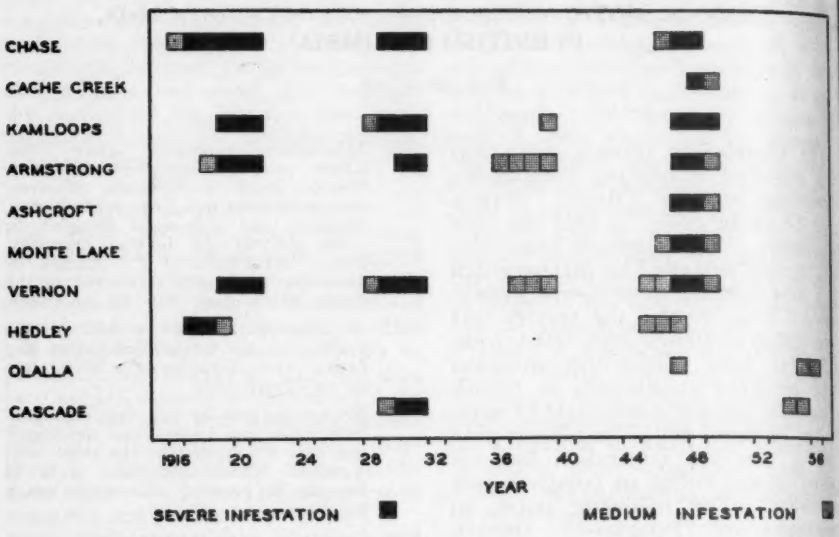

Fig. 1.—Records of occurrence of *Hemerocampa pseudotsugata* McD. infestations from 1916 to 1956 in the interior of British Columbia.

1939—The anticipated increase in population did not materialize. Although larvae were numerous during June and July near Vernon, Larkin, and Armstrong, there was a general population collapse apparently due to a virus. An outbreak reported from the North Thompson Valley during 1939 also subsided.

1945—The Douglas-fir tussock moth reappeared at Vernon and Hedley. Small outbreaks were observed near buildings at these localities.

1946—The infestations at Vernon and Hedley continued, and tussock moth activity was reported from Chase and Princeton.

1947—Young Douglas-fir trees near Chase, Squilax, Pritchard, Monte Lake, Stump Lake, Oregon Jack Creek, Hedley, Vernon, and Armstrong were severely defoliated.

1948—Damage by tussock moth larvae was widespread. Infestations were observed at Armstrong, Vernon, Oregon Jack Creek, Ashcroft, Lower Hat Creek Valley, Walhachin, North Thompson River Valley from Kamloops north to Barriere, and Monte Lake west to Monte Creek. Mortality of Douglas-fir and ponderosa pine trees occurred at all infestations.

1949—The infestations subsided. A survey in the spring of 1949 indicated that the only persistent large population was in the vicinity of Savona. This population collapsed during the summer due mainly to a virus.

1954—A small outbreak was noted at Cascade.

1955—The outbreak at Cascade subsided. A virus apparently was responsible. A light population was discovered at Olalla.

1956—Tussock moth activity near Olalla ceased during the summer. At the time of writing, the cause had not been determined.

From the above listed outbreaks of Douglas-fir tussock moth it is apparent that severe infestations have recurred at intervals (Fig. 1) in a rather limited part of interior British Columbia (Fig. 2). Most of the outbreaks have been in open-grown stands of Douglas-fir trees. The infestations appear to build up quickly in a relatively few suitable sites, last for a short period, and then collapse. Between outbreaks, there are years when

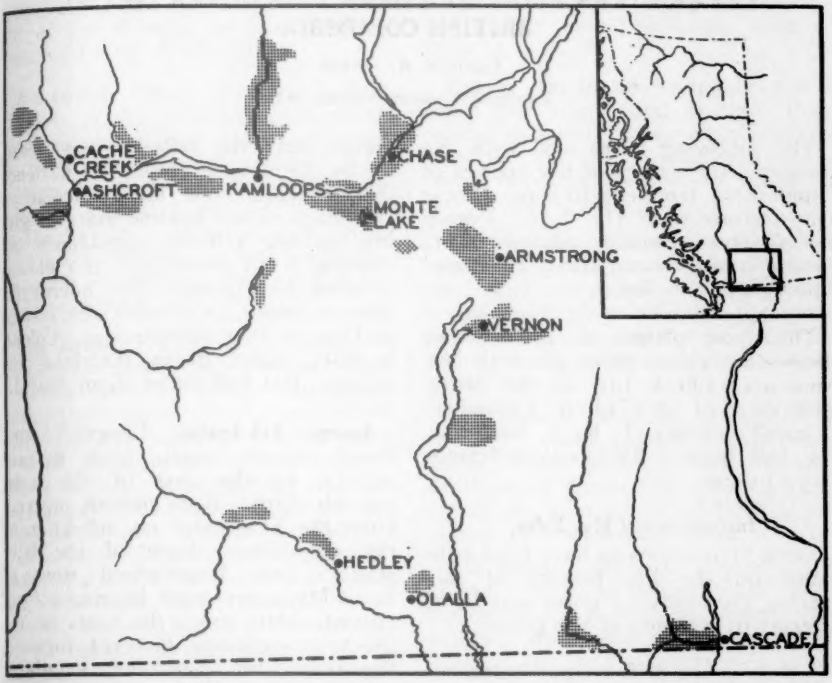

Fig. 2.—Location of past outbreaks of *Hemerocampa pseudotsugata* McD. in British Columbia.

no larvae are taken in the routine survey samples over most of the range of the Douglas-fir tussock moth. On the other hand, there are a few localities, such as Long Mountain near Oyama, where outbreaks have been unknown, but which usually have a small persistent population.

Caenurgina erechtea Blkme.

The following notes are supplementary to my article on the species in the Proc. Ent. Soc. of B.C. **52**: 16-21, 1956

Ova were obtained from the summer form on July 20, 1956. These hatched on July 30. The larvae were fully fed about August 26, and pupated soon afterwards. Adults emerged September 21 to 26, all of the large summer form. Matings occurred and ova were obtained October 8, and for a few days after. Some of the ova hatched, but the larvae did not feed; the remainder failed to hatch though the embryos were fully formed.

From material in collections it was assumed that the summer brood would have overwintered in the pupal stage, giving rise to the small spring form. However, these observations suggest that two generations of the summer form are usual in this area; and it is conceivable that, given ideal growing conditions, and a long summer season, this species might be triple-brooded. In that case progeny from an early, third generation would develop sufficiently to produce overwintering pupae.—*George A. Hardy, Provincial Museum, Victoria, B.C.*

NOTES ON THE LIFE HISTORIES OF FIVE SPECIES OF LEPIDOPTERA FROM SOUTHERN VANCOUVER ISLAND, BRITISH COLUMBIA

GEORGE A. HARDY

Provincial Museum, Victoria, B.C.

The following notes deal with the complete life history of five species of Lepidoptera, from egg to pupa. These are: *Incisalia mossi* Hy. Edw., *Venusia pearsalli* Dyar, *Perizoma curvilinea* Hlst., *Spodolepis substriataria danbyi* Hlst. and *Xylomiges candida* Sm.

The food plants of the various species are either those given in "An Annotated Check List of the *Macrolepidoptera* of British Columbia" (Llewellyn-Jones, J. R. J., Ent. Soc. B.C. Occ. paper 1, 1951) or supplementary to them.

Incisalia mossi Hy. Edw.

Since little seems to have been published on the life history of this species, the following notes may be of interest to students of the genus.

I. mossi is one of four species recorded for British Columbia. It is a small, inconspicuous, dark brown butterfly, rather local, usually found on steep, rocky slopes that face west, where the food plant, *Sedum spathulifolium*, grows abundantly. It flies from late March to mid-May.

To secure ova, females were repeatedly caged over various shrubs and trees during several years, but without results. Eventually it was noticed that the stonecrop, *Sedum spathulifolium*, was always near the haunts of *I. mossi*, and after caging the butterflies with stonecrop, ova were finally obtained and the caterpillars readily reared. Several caterpillars of different ages were studied, and the data obtained averaged for the following sequences.

Ovum. Ova deposited, singly April 14 to May 2, on the tip of the bracts or at the base of the flower buds; sometimes on the underside of the leaves near the inflorescence. Size, .75 by .33 mm. A somewhat flattened disc covered with fine reticulations that have raised hyaline margins giving the egg a hoary appearance and causing it to blend into the bloom-covered food plant. The micropylar area is deeply sunk below the surface and has smaller reticulations. Colour, a pale, pastel green matching the leaves. Hatched on or about May 1.

Larva. 1st Instar. Length 1.5 mm. Head piceous brown, large in proportion to the rest of the body, smooth, shiny. Body smooth, tapering from the head with no indication of the onisciform shape of the later stages; four longitudinal rows of small black dots each bearing a long, curved, white hair; the hairs on the thoracic segments directed forward, the remainder backward; length of hairs about equal to width of body. A small, dark brown plate on the dorsum of the first thoracic segment. The ninth abdominal segment flattened, rounded at the tip, held in a horizontal position; a small dark spot present on the dorsal surface at the base. Growth was comparatively slow at first; the caterpillars finally bored through the base into the heart of the bud where, hidden from view, they fed on the ovary and anthers.

2nd Instar. May 12. Length 5 mm. Head dark brown; body honey colour to greenish yellow, a faint lighter dorsal line, evenly covered with a short, dense, light brown pile. Onisciform shape now obvious, the head retracted within the first thoracic segment. Abdominal segments 1 to 7 with a pair of oblique, brownish stripes. Fragments of the bloom from the food plant entangled among the hairs helped to camouflage the caterpillars. At the conclusion of this

stage they could be seen half in, half out of the flowers, or partly curled round the stem at the base.

3rd Instar. May 20. Length 10 to 12 mm. Fully onisciform, segments much ridged, folded and overlapping. A prominent lateral fold. Head piceous to dark brown. Body pale greenish yellow, matching the colour of the flowers; spiracles pink ringed with black; oblique stripes as before. In some caterpillars the stripes are faint or absent.

4th Instar. May 25. Length 16 to 17 mm. Head dark brown. Body greenish yellow, some caterpillars with stripes edged dorsally with white, spiracular fold whitish in some cases. May 28. Length 18 to 20 mm. Caterpillars mature; pupated May 31. Before pupation the caterpillars left the food plant and sought a sheltered niche. In confinement one caterpillar chose the side of a flower pot under some dry moss; others chose the bottom of the rearing jar. First they spin a light silk mat then over the fore part of the body a silken girdle which is attached to the mat. The tip of the last abdominal segment is also attached to the mat.

Pupa. Size 11 by 7 mm. Short and squat; pale yellow to beige at first, eventually becoming dark chocolate; a pale dorsal line flanked by a double row of small fuscous dots on each side. Spiracles white.

Imago. One emerged April 3.

One group of caterpillars ate the leaves and parts of the stems when confined over a plant from which the flowers were faded or absent. Caterpillars reared on the flowers were yellow, but those with the varied diet ranged from a dark vinaceous red through flesh-pink to greenish-yellow, with the oblique stripes more prominently marked.

Venusia pearsalli **Dyar.**

Ovum. A female taken in Saanich laid several ova May 6 and 7, 1956. Size .6 by .5 mm., slightly flattened. minutely reticulate, pale green, becoming darker just before hatching on May 14.

Larva. 1st Instar. Length 1.5 mm. Head pale translucent brown. Body semi-translucent pale, whitish-green. Very restless at first, nibbled at ocean spray, *Holodiscus discolor*, but finally fed on red alder, *Alnus rubra*.

2nd Instar. May 18. Length 4 mm. Head pale green, almost colourless, and translucent. Body pale green, with glaucous inter-segmental rings, and small, pale brown, tubercle-like dots, each bearing a short, white hair.

3rd Instar. May 24. Length 6 to 10 mm. Head translucent, greenish white. Body green, a dark, suffused, deep-seated dorsal line showing heart pulsations, thin white subdorsals, pale yellow intersegmental rings.

4th Instar. May 31. Length 15 to 17 mm. Head as before. Body apple green above, sage-green below, pale yellow, somewhat incomplete subdorsals, legs and claspers pale green, spiracles indistinctly greenish. Larvae hid among folded leaves when not feeding. Larvae full-fed on June 10, pupated between the leaves or in slight depressions in the soil.

Pupa. Size 8 by 3 mm. Shiny, lightly punctate, pale brown abdominal segments; cremaster about six spinous hairs, twisted together and set on a rugose base.

Perizoma curvilinea **Hlst.**

Ovum. Twenty ova from one female taken in Saanich, were laid irregularly on the bottom and sides of a chip box, August 13, 1956. Size, 1.0 by .75 mm., depressed oval, slightly larger at one end; smooth, with well defined reticulations; creamy white. Hatched August 22.

Larva. 1st Instar. Length 4 mm. Very slender. Head pale brown. Body colourless, semi-transparent with sparsely distributed short hairs. Did not eat the egg shell. Fed on ocean spray, *Holodiscus discolor*, after trying a number of herbs and shrubs.

2nd Instar. August 27. Length 7 mm. Head pinkish-brown. Body brownish-green blending into a lighter coloured, supra-spiracular line with its ventral border maroon; underside pinkish.

3rd Instar. September 3. Length 12 mm. Head milky-white with light brown feathering on sides and centre. Body light brown with short, scattered, black hairs.

4th Instar. September 9. Length 15 to 20 mm. Head sienna, with two vertical, whitish bars. Body pale rusty to sienna, with a faint pink tinge, spiracular line maroon, underside paler with a pale-bordered, dark, interrupted central line.

Full fed on September 18. Length 25 mm. Head as before. Body as before but with indistinct double dorsal, and single subdorsal lines; underside with two pale yellow lines slightly divergent on centre of each segment. Pupated September 22, within a slight cocoon among debris.

Pupa. Size 10 by 2.5 mm. Almost cylindrical, smooth, dull, red-brown; cremaster, two parallel spines recurved at tip in same plane and at top of a rugose conical base.

Spodolepis substriataria danbyi **Hlst.**

Ovum. A female taken in Saanich laid 14 ova April 23, 1956. Size, 1.0 by .9 mm. Oblong-oval, finely striate and cross-ribbed; pale cream, turning a salmon colour in a day or two. Hatched May 10.

Larva. 1st Instar. Length 4 mm. Slender, very active. Head light brown with darker mottlings. Body translucent purplish-brown, with two light lines; underside with two purplish stripes; body colour intensified on centre of some segments giving a ringed effect.

2nd Instar. May 15. Length 6 to 12 mm. Head square, pale pinkish, with three brown areas one on each side and one on the vertex. Body grey-green with several longitudinal lines; a faint, dark green dorsal, a white subdorsal, and a broad whitish spiracular line; spiracles ringed with black; underside with a wide whitish central band and a thinner one on each side; a pair of black dots on dorsum of each of abdominal segments two to seven. Fed on willows, *Salix mackenziana* and *S. scouleriana.*

3rd Instar. May 21. Length 12 to 15 mm. Head whitish, heavily speckled with dark, greenish-brown, leaving two white bars on each side of the face. Body sage green, four black dots on dorsum of each segment, two pairs forward and two backward, with fine lines connecting the outer dots; the dorsal space between darker, and tinged with green; a conspicuous black line just below the spiracles; underside grey with a broad whitish central line; Thoracic segments with a central, black line on dorsum. Some larvae bluish grey with several thin, white lines breaking up the ground colour; spiracles black, a tinge of yellow along the spiracular line.

4th Instar. May 23. Length 22 to 25 mm. Head pinkish, heavily spotted with black on sides and top, leaving a white bar on each side continuous with sub-dorsals. Body colour and markings intensified, general colour grey to warm brown, imparted by fine brown vermiculations on a white and ochre base; dorsum of first thoracic segment with a black line, a pair of black spots on the second and third, the spots joined by a dark oblique line; a transverse black bar on the seventh abdominal, which has a corresponding raised ridge; hour-glass fuscous outlines on dorsum of abdominal segments. Some larvae have underside concolorous with dorsum; spiracles pink, ringed with black.

5th Instar. June 5. Length 28 to 35 mm. Head pale blue-grey, heavily spotted with fuscous, leaving two parallel vertical bars on the sides; Thoracic segments as before, first to seventh abdominal segments with suffused, diamond-shaped marks on dorsum; general colour light grey to

sienna brown; underside pearl grey with wide, dark brown sub-spiracular line. Some larvae are uniformly sienna brown with no dark sub-spiracular line; dorsal pattern chiefly pale cream transverse marks between each segment. Larvae full-fed by June 8.

Pupa. Contained in a light cocoon spun on the surface of the ground under leafy debris. Size 14 by 4 mm. Slender, elongated, smooth, shiny; wing cases finely wrinkled; abdomen punctate around centre of each segment; dark, piceous brown. Cremaster, two stout spines, with recurved tips, subtended by 4 to 6 short, slender recurved hairs, all on a conical, rugose base.

Xylomiges candida Sm.

This is a Western American species, on the wing from March to May. It may be found at rest on tree trunks by day and is attracted to light by night. Wing expanse 35 to 38 mm. the primaries mottled with light and dark grey, the secondaries satiny white, hence the specific name which means shining white. No referable account is available to me, and no mention of the food plant is recorded in Jones' list.

Ovum. A captured female from Saanich, land a group of about 110 ova May 10, 1955, piled together in three layers in a low pyramid. Size .5 to .3 mm., a flattened oval, vertically ribbed, shiny white with a light brown ring around the upper part, microplyar area marked with a brown dot, becoming darker at maturity; hatched May 30.

Larva. 1st Instar. Length 2 mm. Head light brown, dotted with black. Body transluscent purplish, with a few short hairs. The larva consumed the egg shell. Young caterpillars very active, soon scattering in all directions. They commonly spin a suspensory thread.

2nd Instar. June 10. Length 8 to 10 mm. Head pale greenish dotted with black. Body pale green to bluish, with black dots, each segment bearing a short hair; thin, white dorsal and sub-dorsal lines edged with fuscous. Spiracular line broad, white. Feeds preferably on broad leaved maple, *Acer macrophyllum,* but also feeds on *Salix scouleriana* and *Alnus rubra.*

3rd Instar. June 15. Length 20 mm. Head as before. Body varying shades of drab green, or brown, Thin, white dorsal and sub-dorsal lines sometimes present; spiracular line broad, white, edged dorsally with black.

4th Instar. June 22. Length 25 to 35 mm. Head pale brown with a small darker oblique stripe on each side of the vertex, and darker reticulations on the sides. Body red-brown with fine etchings and irrorations of fuscous. Dorsal and sub-dorsal as before; spiracular with a faint rusty tinge along the centre of the broad white band; spiracles white, ringed with black. Underside concolorous with the upper. Larvae full grown June 28; varying from pinkish-brown to dull, fuscous brown, with interrupted dark dorsal line, and little or no evidence of sub-dorsals. The fully fed larva was 40 mm. long. Larvae rest between the leaves, and curl into a ring when disturbed. July 9. Most of the larvae formed tough cocoons below the surface of the soil.

A larva taken on *Arbutus menziesii* July 3, 1953, matched the arbutus stems, a bright sienna. This one pupated on July 26 and emerged on April 15, 1954.

Pupa. Size 16 by 6 mm. Smooth. shiny, wing cases dark, piceous brown; abdomen light brown with short, dark streaks scattered over the segments. Cremaster, two stout, outwardly recurved, hooked spines, with four shorter, slender spines at the base; all placed directly on the tip of the last segment, and not on a raised tubercle as is commonly the case.

Imago. Emerged April 3 to 16, 1956.

UNUSUAL DAMAGE TO POTATOES BY THE TWO-SPOTTED SPIDER MITE, *TETRANYCHUS TELARIUS* (L.), IN THE LOWER FRASER VALLEY[1]

H. G. FULTON[2]

Entomology Laboratory, Chilliwack, B.C.

Early in July, 1956, it was observed that the tops of late Netted Gem potatoes were browning and dying off in a 14-acre field at Sardis, British Columbia. Investigation showed that the damage was caused by large numbers of the two-spotted mite, *Tetranychus telarius* (L.)[3]. Infested areas were particularly noticeable at the edge of the field adjoining a ditch and hedgerow of weeds and brush. Later in July and during August similar damage was found in potato fields at Colebrook and Cloverdale. Although this mite has been recorded as a pest of potatoes in Washington and Idaho, this is the first time to the writer's knowledge that it has damaged potatoes in British Columbia. Large populations of the mite were also observed on sweet corn, pole beans, and marigolds at different locations.

The factors favouring the outbreak are not clearly understood. The summer was generally hot and dry but no records were set. However, general weather conditions must have been favourable for the rapid multiplication of the mites. A possible contributory factor is the widespread use of DDT to control the tuber flea beetle. Various researchers have shown that use of DDT is followed by an increase in the abundance of mites. Some say that the natural predators are killed (Pickett, 1949); others claim that mites exposed to DDT lay more eggs (Hueck, 1955); still others state that the insecticide brings about changes in plant nutrition and composition (Klostermeyer and Rasmussen, 1953).

The situation is worth watching since one or more of the recently introduced control practices for other potato pests may favour increase of the mite.

1. Contribution No. 3648, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada.
2. Technical Officer.
3. Identified by C. V. G. Morgan, Entomology Laboratory, Summerland, B.C.

References

Pickett, A. D. A critique on insect chemical control methods. Can. Ent. 81: 67-76. 1949.

Hueck, H. J. The population-dynamics of the fruit tree red spider with special reference to the influence of DDT. Proefschr. Rijksuniv, Leiden, 148 pp., 1953. Rev. Appl. Ent. (A) 43: 340-342. 1955.

Klostermeyer, E. C. and W. B. Rasmussen. The effect of soil insecticide treatments on mite population and damage. J. Econ. Ent. 46: 910-912. 1953.

The Wharf Borer in a Vancouver Branch Library

In June, 1956, I was asked to investigate some beetles which the librarians of a branch library had found flying around the premises and had tentatively identified from literature as *Nacerda melanura* (L.), the wharf borer. Their identification was correct.

In volume 43 of the Proceedings of our Society, I published an article "An unusual record of the wharf borer in buried piling", reporting that this beetle bred at tidewater in piling that had been covered by a slab of concrete for thirty years. The branch library is a one-storey, 1500 square foot building, located on top of a little hill with natural drainage on all sides. There is no basement and only small ventilator openings in front, so that most of the floor is over a dead air space. In February, 1957, the library was closed for 10 days for repairs to the floor and I was able to procure half a sinkful of sodden black lumber which the carpenters had thrown out from underneath the floor. Some 16 *N. melanura* emerged from this material in the course of the next six weeks.

Adults of both sexes are most erratic in their movements, tearing around in all directions and then suddenly becoming motionless. A beetle will cover a territory for a considerable period like a hound on a scent and then suddenly dart off to another piece of wood or down a larval or a termite burrow, to emerge shortly and repeat the performance. Adults apparently need no food. One or two males will follow a female for long periods. Eggs are laid singly or in small groups, as far down into crevices as females can place them with their considerably extendable ovipositors. The eggs are 1 to 1.2 mm. long, white, long-oval, slightly curved or straight-sided. They hatch in from 5 to 7 days and the white larvae, 1.5 to 2 mm. long wander for days on the surface of sodden wood before boring in. Of two females dissected, one was nearly spent and yielded 35 eggs while the other, heavily gravid, contained 215 eggs of a uniform size suggesting that the full quota must be laid in a relatively short time.

This record shows that the wharf borer is spreading in Vancouver and may turn up in sodden timbers in the underpinnings of buildings which have poorly ventilated or completely saturated air spaces under them. Since the larvae feed only in sodden, rotting timber, the beetle is an indication of decay and not a cause of it.—*G. J. Spencer, Dept .of Zoology, University of British Columbia.*

A further note on *Laelius* sp., Hymenoptera: Bethylidae, a parasite on the carpet beetle *Anthrenus pimpinellae* Fabr.

In Vol. 39 of the Proceedings of our Society I published a note with approximately the above heading except that the specific name of the beetle was given as *scrophulariae,* after an identification made for me by the late Ralph Hopping. At that time I had not taken *A. scrophulariae,* the Buffalo Carpet beetle, in this province, but within the last few years it has become established in homes in Mission and Haney. It may commonly be taken on white flowers at Mission, in summer.

From Hinton's book (Hinton, H. E. A monograph of the beetles associated with stored products. Vol. 1, Brit. Mus., 1945), I found that the beetles which Hopping called *A. scrophulariae* showed the colour patterns of *A. pimpinellae* var. *lepidus* Lec. Later when George Hopping arranged our beetles, he placed the specimens under *A. occidens* Csy.

This beetle is a scavenger in birds' nests, the larvae feeding upon feathers and the scales from pin-feathers left when fledglings have flown. I have reared them from cliff swallows' nests in the Chilcotin, and from tree swallows' and mountain blue birds' nests at Kamloops. Once at Quesnel I saw the blossoms of a small hawthorn swarming with beetles which had apparently just emerged from the cliff swallows' nests, which plastered the ends of a barn close by. The species is found at the Coast and is widespread in the Interior: I have specimens from Quesnel, Riske Creek, Kamloops, Nicola, Vernon, Salmon Arm, Trinity Valley, Merritt, Spence's Bridge and Victoria.

In 1956 the Department of Zoology received several cabinets of bird and mammal study skins, bequeathed to the University by the late James Wynne of Enderby. One of the boxes of about 12 cu. ft. capacity held some loose bird skins and from the bottom of this box I collected 11 pupal cases of *A. pimpinellae* of which 9 contained the mass of tight silk threads, indicative of *Laelius* parasitism, bulging above the level of the old larval skin in which pupae of dermestids typically occur. In most cases, a short emergence tube of the parasite extended up from each mass, opening either forwards or backwards. Loosening the silk with needles revealed from two to four others, underneath each tube, indicating that each beetle pupa had supported from three to five parasites. This is the highest degree of parasitism by *Laelius* that I have encountered, namely nine out of eleven pupae or about 80 per cent. Enderby is between Armstrong and Salmon Arm in the North Okanagan, but according to Dr. O. Peck (Proc. Ent. Soc. B.C. **39**: 21-22, 1942) Whittaker's type of *occidentalis* was taken from a window in Chilliwack, on the lower mainland. There is hope, therefore, that this parasite or a closely related species of *Laelius,* may become abundant in Vancouver where *Anthrenus verbasci* (L), the varied carpet beetle, is a household pest of the first magnitude.—*G. J. Spencer, Dept. of Zoology, University of British Columbia.*

THE EFFECT OF DOUGLAS-FIR LOG AGE ON ATTACK BY THE AMBROSIA BEETLE, *TRYPODENDRON LINEATUM* (OLIV.)[1]

by

J. M. KINGHORN AND J. A. CHAPMAN

Forest Biology Laboratory, Victoria, B.C.

Trypodendron lineatum (Oliv.), which flies in the first warm days of spring, prefers to attack trees felled the preceding autumn or winter rather than those freshly cut. Gaumann (1) showed that in Europe, spruce and fir felled from March to August were free from attacks by this species Attacks were heaviest on trees cut in October, November and December, although January-felled spruce was also heavily attacked. Observations by Hadorn (2) supported these findings. Among a 24-month series of hemlock cuttings conducted by Mathers (5), only logs older than five months were attacked by *Trypodendron.* Patterson (6) found from a series of hemlocks felled in different months, that average density of attack progressively diminished from 60, in December-felled, to 0.5 holes per square foot in April-felled trees. The same preference for autumn-winter felled trees was also shown for Douglas-fir, grand fir and western hemlock by Prebble and Graham (7). Exceptions have been recorded where trees felled as late as March and April have been attacked (4, 7), but in general, freshly cut trees are least attractive. The reason for *Trypodendron* preference of logs cut in autumn or winter is not yet clear. We recently conducted an experiment to determine the relation of attack density to time between felling and attack.

It is probable that both the quantity and quality of food reserves and other organic materials in the sapwood undergo changes after felling. If these changes are brought about by the continued functioning of living cells, it should be possible to arrest them by killing the cells. Wilson (8) demonstrated that prolonged functioning of the sapwood cells after cutting depleted starch in the sapwood of oak and ash. In contrast, the early death of these cells resulted in the maintenance of the starch reserve and therefore of susceptibility to *Lyctus* beetle attack.

Jover (3), in the Ivory Coast, increased ambrosia beetle attacks on Avodire eightfold by boiling the wood for 48 hours soon after felling. He suggested that the heat, by suppressing enzymatic action, prevented the depletion of stored starch which would occur under natural conditions.

Methods

In planning the experiment, the following variables had to be considered in relation to the log aging process: (a) seasonal temperature fluctuations; (b) changes in log moisture; and (c) inter- and intra-tree variability in attractiveness to beetles. To minimize the effects of these variables, the following procedure was used. Two Douglas fir were felled February 7, 1956, and each cut into twenty-four 18-inch blocks. The blocks from each tree were then divided into six groups of four adjacent sections. One section from each group served as a control for the other three which received various treatments. The controls were essentially maintained as they were at time of felling by storing them in plastic bags at 0°F., after first waxing the cut ends.

Four series were aged as described below. From each tree, a set of blocks with the ends waxed were aged. Another series from Tree "A" was aged without waxing the ends. The fourth series, from Tree "B" was autoclaved at 20 pounds pressure for two hours before aging. This was done to simulate Jover's (3) boiling treatment and it undoubtedly arrested the cellular or enzyme activity in the

1. Contribution No. 400, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.

sapwood. The bark was loosened on most of these blocks but it was tacked onto the sapwood immediately after autoclaving and the cracks coated with wax. Weight measures before and after autoclaving showed an average water loss of about one pound per block (blocks averaged 33 pounds).

All sections to be aged were placed in the basement of the laboratory where the temperature remained near 72°F. Moisture changes were minimized by standing the sections on moist sand and covering them with plastic bags. Every fortnight for 12 weeks, one block from each age-series was moved to refrigerated storage (0°F.), thus preventing further change.

On May 17, during a period warm enough to initiate *Trypodendron* flights, the blocks were taken from refrigerated storage to Cowichan Lake, where they were set out in a partly shaded clearing near a recently logged area where numbers of *Trypodendron* were likely to appear. All blocks were weighed just after they were cut, and again when they were placed in the forest. Most of them showed little change in weight, although the unparaffined, aged sections from Tree "A" had gained weight slightly. This increase can be attributed to water absorbed into the wood from the damp sand during aging. On July 16, the blocks were debarked and all *Trypodendron* attacks counted.

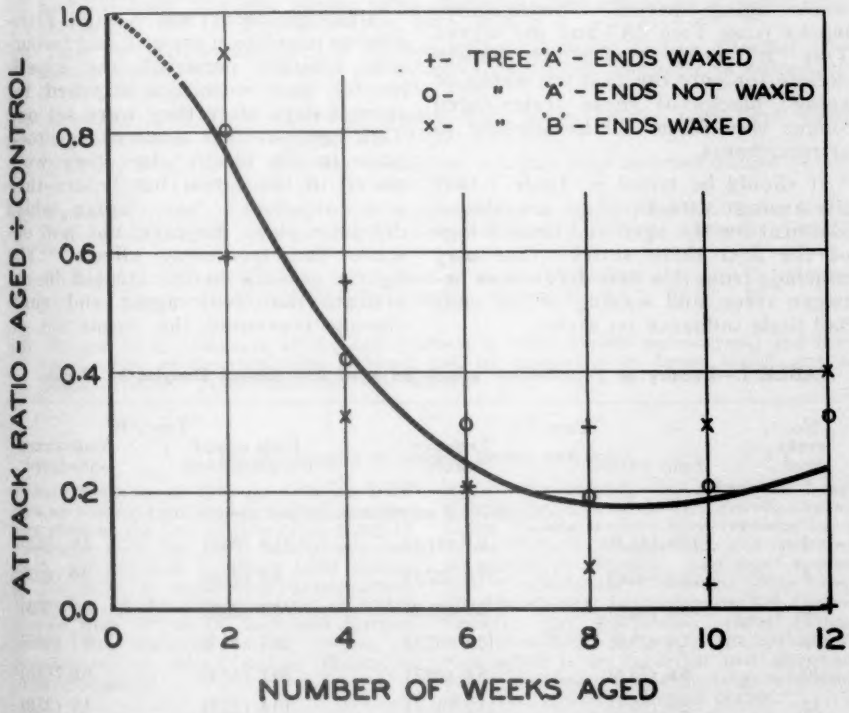

Fig. 1.—Individual values and free-hand curve showing the relation of attack on aged blocks (expressed as a proportion of attack density on corresponding control blocks) to length of time aged. The autoclaved series is not shown.

Results

Trypodendron were noted flying near the logs during the first few days they were in the field, but after six days, only six attacks could be found, and five of these were on control sections. By May 29, however, 155 attacks were counted, 138 of which were on control blocks. The final examination, in July, also showed that the beetles preferred the un-aged wood (Table I). Among the groups that were not autoclaved, density of attack varied inversely with time of aging. This relationship is illustrated in Figure 1, where the attack preference is expressed as the ratio of aged-block to corresponding control-block attack density. The aged, waxed series from Tree "A" show a constantly declining attractiveness to the beetles for the entire 12-week aging period. Unparaffined blocks from Tree "A" and the waxed Tree "B" series show attack density decline for only the first six weeks of aging; blocks of these series aged longer showed no further decline in attractiveness.

It should be noted in Table I that the average attack values are almost identical for the aged and control logs of the first three series. One may conclude from this that differences between trees, and waxing of cut ends had little influence on attack.

In comparison with the other logs, those that were autoclaved received much less attack. Attack on the autoclaved-control blocks was less than half that on the other controls, and the autoclaved-aged series was almost free of attack.

The basal four-foot section of Tree "A" was not used for the experiment, but was left in the forest near Victoria where the trees were cut. It was interesting to find in July that this section had received 14.1 *Trypodendron* and 12.7 *Gnathotrichus* attacks per square foot. The combined attack density of the two ambrosia beetles was thus equivalent to that on the experimental control blocks at Cowichan Lake.

Discussion and Summary

Although there was a high *Trypodendron* population present, and favourable weather persisted, the experimental logs were not attacked for several days after they were set out. This suggests that some change took place in the blocks after they were placed in the forest but before they were attacked. Any change which did take place however, did not obscure the treatment effects. The lighter attacks on the treated blocks indicate that both aging and autoclaving prevented the formation of,

TABLE I.—Density of *Trypodendron* attack on aged and control Douglas-fir blocks.

No. weeks aged	Tree "A"		Tree "B"	
	Ends waxed	Ends not waxed	Ends waxed not autoclaved	Ends waxed autoclaved
	(Number of entrance holes per square foot)			
2	19.9 (33.3)[1]	9.2 (11.4)	25.3 (26.0)	2.9 (2.5)
4	22.5 (40.6)	11.8 (27.7)	9.0 (27.8)	2.9 (16.3)
6	9.8 (46.0)	6.7 (21.2)	4.3 (20.4)	0.7 (17.3)
8	7.9 (25.3)	12.5 (62.8)	3.1 (42.4)	0.7 (12.3)
10	0.6 (13.3)	5.0 (23.7)	10.1 (32.3)	0.0 (13.8)
12	0.0 (16.5)	15.2 (45.7)	10.4 (25.9)	1.9 (23.0)
Treatment Means	10.1 (29.2)	10.1 (32.1)	10.4 (29.1)	1.5 (14.2)

[1] Density of attack on corresponding control blocks

or depleted some attractive substance. It is probable that the heat treatment destroyed or inhibited attractant formation. On the other hand, lessened attack on the unautoclaved aged wood may be attributable to continued cellular activity. Conditions during aging were similar to those described by Wilson (8) as favourable for prolonging the life of sapwood cells of oak and ash. Under such conditions, the living cells deplete starch reserves that reach a maximum during midwinter in these species. It is reasonable that this depletion principle applies to our aged Douglas-fir, but iodine tests both at the time of felling and after aging failed to reveal the presence of starch.

The experiment was limited in scope but it serves to point out the need for more information on the occurrence and seasonal fluctuations of various sapwood constituents in relation to ambrosia beetle selectivity.

References

(1) Gaumann, E. Untersuchungen uber den Einfluss der Fallungszeit auf die Eigenschaften des Fichten- und Tannenholzes. II. Teil. Einfluss der Fallungszeit auf die Dauerhaftigkeit des Fichten- und Tannenholzes. Beihefte zu den Zeitschriften des Schweiz. Forstvereins, 6: 26-32. Buchler and Co., Bern. 1930.

(2) Hadorn, C. Recherches sur la morphologie, les stades évolutifs et l'hivernage due bostryche liseré (*Xyloterus lineatus* Oliv.). Supplément aux organes de la Société forestière suisse. No. 11. Buchler and Co., Bern. 1933.

(3) Jover, H. Note préliminaire sur les modalitiés de l'attaque du bois d'Avodiré (*Turreanthus africana* Wlw. Pellegrin) par différents coléoptères xylophages en Basse-Côte-d'Ivoire. Rev. Path. Veg. 30 (1): 54-55. 1951.

(4) Kinghorn, J. M. An induced differential bark beetle attack. Can. Dept. Agric. Forest Biol. Div. Bi-Mon. Prog. Rpt. 13(2): 3-4. 1957.

(5) Mathers, W. G. Time of felling in relation to injury from ambrosia beetles or pinworms. B.C. Lumberman 19 (8): 14. 1935.

(6) Patterson, G. A. Ambrosia beetle control measures in the Nimpkish Valley during 1953. (Unpublished). Private report, Canadian Forest Products Company Limited. 1954.

(7) Prebble, M. L. and K. Graham. Studies of attack by ambrosia beetles in softwood logs on Vancouver Island, British Columbia. Forest Science 3: 90-112. 1957.

(8) Wilson, S. E. Changes in the cell contents of wood (xylem parenchyma) and their relationships to the respiration of wood and its resistance to *Lyctus* attack and to fungal invasion. Ann. Appl. Biol. 20: 661-689. 1933.

On the iniquity of blanket sprays and dusts

One afternoon in 1946 as soon as DDT became available, I treated several quarter-acre plots on the Lac du Bois range north of Kamloops, with 3% DDT in diatomaceous earth, put out with a rotary hand duster, in the hope of controlling grasshoppers. Vegetation on the plots consisted of mixed grasses from 12" to 18" high and Russian thistle, and harbored several species of grasshoppers of mixed instars (hereafter caller groppers).

The plots were examined next forenoon. The effect on the groppers was negligible and continued so, but on some other insects it was literally shocking. Leafhoppers and mirids were wiped out and many dead and dying beetles, for the most part harmless, lay on the ground. Mr. Hugh B. Leech identified the beetles as: *Percosia extensa* Casey, *Harpalus basilaris* Kby. (*obesulus* Lec.), *Amara* (Celia?) *subaenea* Lec., and *Amara* sp. (Carabidae); *Cicindela longilabris montana* Lec. (Cincindelidae); *Coniontis oblita* Casey (Tenebrionidae); *Serica anthracina* Lec. (Scarabeidae); and *Brachyrhinus ovatus* (Linn.) (Curculionidae). *B. ovatus*, the strawberry root weevil is an important pest elsewhere but is harmless on a cattle range five miles from the nearest cultivated plants.

This dust tested again on Canada blue grass without weeds, killed off the large population of leafhoppers present and a few ground beetles. It was 12 days before the area began to be repopulated centripetally from the surrounding vegetation.

At Quesnel one afternoon in 1948 I dusted a considerable area of tall, sparse-growing alfalfa with 3% DDT dust to watch its effect against a heavy infestation of *Lygus oblineatus* Say and *L. elisus* Van D. and some leafhoppers; by next morning not one of these insects was alive on the plot and again it was nearly two weeks before the area began to be repopulated. The effect of the dust on insects other than Hemiptera-Homoptera was not observed.

At Vancouver one evening in early May 1957 I sprayed some lilac bushes and a tall privet hedge with a mixture of DDT and benzene hexachloride against the leaf miner *Gracilaria syringella* Fab. Next morning *Carabus nemoralis* Mul. beetles were lying paralyzed in some numbers up to 9 ft. from the hedge and others continued to die even 13 days after the spraying. Carabidae or ground beetles are very susceptible to modern residual insecticides. Every autumn numbers of *Pemphus angusticollis* (Mann.), *Carabus granulatus* L., and *C. nemoralis* Mul. find their way into the basement of our home and run over the floor which has had residual insecticides splashed on it and the beetles very soon become paralyzed and die.

These records show the possibly unavoidable slaughter of innocents, but the situation will become really serious in many large gardens in Vancouver which have fallen into the hands of men who glibly talk the owners into yearly contracts for periodical blanket sprays for controlling ALL insects. These operators use very powerful sprayers mounted on trucks with two large tanks containing two spray mixtures. The spray gun can throw a towering jet that will reach to the top of a 30-ft. tree, or, by a twist of the wrist, a very fine mist. In both cases the jet is almost of gale force, bending the vegetation right over.

I asked an operator what he was using and what insects he was supposed to kill; he had no idea whatsoever but stated that the company for which he worked had many contracts and he was working seven hours overtime per day to cover the ground. So he was drenching everything from tall Colorado blue spruce, Douglas firs and maples to border plants whether they needed it or not. I examined parts of one garden ahead of the spray and found no pests anywhere.

Granted that the vacua formed by such wholesale sprays will gradually fill in from surrounding properties, but the whole principle is wrong from a biological standpoint since it has been shown by many entomologists that modern residual insecticides may be more potent against parasites, especially Hymenoptera, than against the pests themselves.—*G. J. Spencer, Dept. of Zoology, University of British Columbia.*

BOOK REVIEW

Annual Review of Entomology, Vol. 2. (*E. A. Steinhaus* and *R. F. Smith*, editors). 1957. Annual Reviews, Inc., Palo Alto, Calif., pp. vii - 407.

The first volume in this series (1956) was widely and favorably reviewed. Now appears Volume 2, thinner by 59 pages but maintaining the high standard, and with it the prospectus for Volume 3. The bindings are good and the format attractive considering the limited budget.

Minor useful items are the running page titles of authors and subjects, the index of authors quoted and the adequate subject index. Less readily usable are the literature citations without titles, more than half of them arranged non-alphabetically. The brevity is necessitated by questions of space and economics, but the citations might be rearranged with little trouble.

The chapters originate as follows: from the U.S.A. 7, the U.K. 7. Canada 3, Australia 2, and Israel 1. The topics and authors follow: Digestion in insects, *D. F. Waterhouse*; Some aspects of intermediary metabolism of carbohydrates in insects, *M. Rockstein*; The physiology of insect cuticle, *V. B. Wigglesworth*; The comparative morphology of the insect head, *E. M. DuPorte*; Cytogenetics and systematic entomology, *M. J. D. White*; The taxonomic significance of the characters of immature insects. *F. I. van Emden*; Caste determinations in social insects, *M. V. Brian*; Dynamics of insect populations, *M. E. Solomon*; The synoptic approach to studies of insects and climate, *W. G. Wellington*; Insect migration, *C. B. Williams*; Recent advances in veterinary entomology, *A. W. Lindquist* and *E. F. Knipling*; Transmission of disease agents by Phlebotomine sand flies, *S. Alder* and *O. Theodor*; Genetics of insect resistance to chemicals, *J. F. Crow*; The mode of action of insecticides exclusive of organic phosphorus compounds, *P. A. Dahm*; Chemistry and mode of action of organophosphorus insecticides, *E. Y. Spencer* and *R. D. O'Brien*; The behaviour of systemic insecticides applied to plants. *S. H. Bennett*, Aerial application of insecticides, *F. E. Weick* and *G. A. Roth*; Cotton insects and their control in the United States, *J. C. Gaines*; Insecticidal control of the spread of plant viruses, *L. Broadbent*; Pollination of alfalfa and red clover, *G. E. Bohart*. It is a healthy sign that among 72 authors in the 3 volumes is a good representation of young men in full research production, not all of whom are entomologists.

As source books the value of the series can hardly be questioned, either now when the backlog of papers is being reviewed, or later when the reviews are more immediately topical. The question is rather the personal one of whether they are worth 59 cents per month to a hard-pressed professional entomologist. The answer must surely be affirmative.

H. R. MacCarthy.

The Collections of Lepidoptera in the Department of Zoology, University of British Columbia

In 1929 the University purchased what was stipulated and understood to be the entire collection of macro- and micro-Lepidoptera from the estate of E. H. Blackmore. Since that time, however, the United States National Museum reported the gift from Dr. Gates Clarke of "the Blackmore collection of 2,000 specimens"; the Provincial Museum at Victoria reported the acquisition of "The Blackmore Collection"; and the late J. R. J. Llewellyn-Jones told me that he had seen notices of two sales of specimens of "the Blackmore collection of Lepidoptera". How many species and how many specimens the collection originally contained is impossible to say. The University received approximately 1,300 species of 9,900 specimens, but many of the species, especially in the Noctuidae, are represented by single specimens and in some cases by name labels only. There is one cabinet of duplicates and "material for further study".

Within the last three years we have received some valuable additions. When he sold his estate at Duncan, the late J. R. J. Llewellyn-Jones deposited his large cabinet at the University. It contained nearly 5,000 beautifully spread specimens on short English pins, of bright unfaded macros, ending with the Geometridae. This collection was willed to the University when Mr. Jones died. Through E. Ronald Buckell we received the collection made by his uncle, Dr. W. R. Buckell (see Proceedings, Vol. 43). These named, beautifully spread, perfect specimens, are housed in a tall walnut cabinet of 20 drawers. There are 541 species of macros and 232 species of micros, totalling 2,813 specimens, mostly from the Salmon Arm district.

By the will of James Wynne of Enderby, the University received his collection of macro-Lepidoptera the existence of which we had not known. For years Mr. Wynne had sent me valuable ectoparasites from birds and mammals and although we corresponded at intervals, he never mentioned being interested in Lepidoptera. His collection of 2,800 perfectly spread specimens is housed in 30 store boxes.

Both the Buckell and the Jones collections are separate units since they are mounted on short pins and cannot well be incorporated with others on long pins. The Wynne collection is on long pins and is being merged with the main Blackmore collection, which will henceforth be known as the Blackmore-Wynne collection. The Wynne collection is especially valuable since it contains some series of which we had few or no specimens, and some eastern North American forms.

Thus the University collection contains some 19,600 spread and named butterflies and moths of British Columbia and a few drawers of brilliant Tropical forms for demonstration, acquired a few at a time from various donors.—*G. J. Spencer, of Zoology. University of British Columbia.*

Printed by
CHAPMAN & WARWICK LTD.
VANCOUVER, B.C.